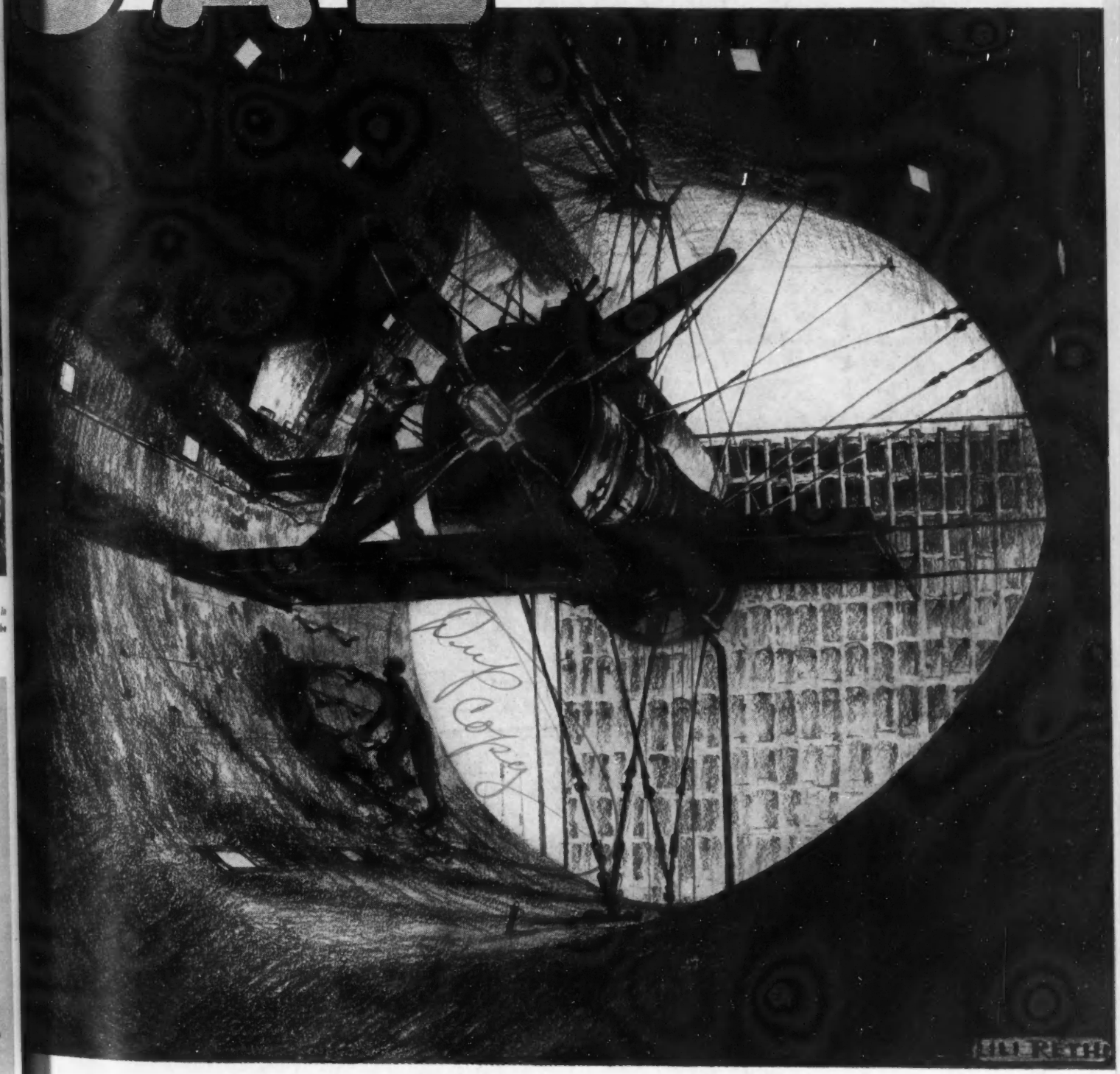
SAE JOURNAL

FEBRUARY 1947



This Issue: 1947 ANNUAL MEETING

Technical Articles on:

Transfer Machines . . . Bus Design . . . Turbo Propellers . . . Management Control . . . Atomic Energy . . . Flopping Flight . . . Air Conditioning — Cars, Planes . . . CAA Program . . . Gas Turbine Future

Rumor Page

IT'S RUMORED THAT

your 1948 car will have a television set!

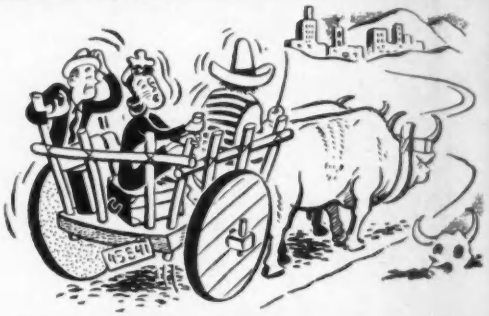
"I'm afraid not!" says Joe LaMarsh, Chief Engineer of Stewart-Warner Television Research Staff. "We are now producing television sets in quantity for homes but practical limitations as well as cost, not to mention driving safety, preclude television for your car in 1948."

IT'S RUMORED THAT

one state capital in the U. S. can't be reached by train, has no railroad facilities!

We scoffed at that till we checked—and found it true! The capital is Santa Fe, New Mexico, and railroad passengers have to get off at Lamy and be taken to Santa Fe by bus or other conveyance.

Contributed by F. E. Nolen, Colyear Motor Sales Company, Los Angeles



IT'S RUMORED THAT

one ring runs rings around other rings as original equipment!

Some Perfect Circle enthusiast must have fostered that one, because it's true that for many years a large majority of manufacturers have used P.C.'s as original equipment. And that includes cars, trucks, tractors, diesels, aviation, bus and stationary engines. Quite a list!

IT'S RUMORED THAT

a racing car only 12 inches long can go 100 mph!

"Right!" says Herman G. Fox, president of the San Francisco Model Midget Association. "In fact, one of our entries was officially clocked at 116.7 mph last season. Incidentally, the Perfect Circles used in these miniature cars are only $\frac{15}{16}$ of an inch in diameter!"

The Perfect Circle Company, makers of Perfect Circle *Custom Made* Piston Ring Sets, will pay fifty dollars ($50) for each rumor, fact or fiction, accepted for this page. Send your rumor to Rumor Page, Perfect Circle, Hagerstown 9, Indiana. All contributions become our property and cannot be returned or acknowledged.

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Americans Demand Opportunity . . .

Here, as abroad, there is an increased demand for security. Clearly, we are unwilling to make the choice now being made by Europe, that is, to trade opportunity for security. It is of the utmost significance that the American people, in the demand for security, have no intention of giving up their system of free enterprise.

We want both opportunity and security, and believe that both can be attained.

With our tremendous productive ability, we should be able to handle our affairs in such a manner as to give a reasonable degree of security to all our people while retaining our historic progressiveness.

The challenge is to develop within the framework of our free society and our system of free enterprise a stable economy that gives both security and a high expanding standard of living.

We are the only country that now has the ability and resources to accomplish this. . . . If we are successful in attaining stability with free enterprise, our success will have great influence on the course of events in other countries. It would be an example to people of other countries to retain the maximum of values of free enterprise and personal freedoms.

W. Averell Harriman,
U. S. Secretary of Commerce

The above paragraphs are excerpts from the address made by Secretary Harriman to the 1947 SAE Annual Meeting Dinner in Detroit, Jan. 8.

2-YARD SHOVEL FILLS 5-YARD TRUCK

in 40 seconds

...with the NEW WAUKESHA Diesel!

● Operating for George M. Brewster & Son, Inc., on the Williamsport, Pa., Flood Control Project, this 2-yard Lorain Shovel, powered with a Model 6-WAKD Waukesha Diesel, averaged 2200 yards of dirt for nine hours on 45 gallons of fuel. That's almost 50 yards per gallon of fuel . . . and heavy digging, to boot!

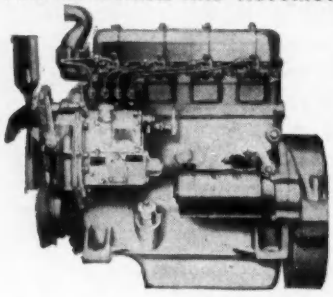
This is a typical example of the fuel economy and power. This new Waukesha Diesel has great acceleration, too, for it makes 3 passes per minute filling a 5-yard truck.

Like all other Waukesha engines, the Waukesha Diesels were not offered to the public until they were thoroughly field-proved and tested. Even before the rumors spread that a postwar Waukesha Diesel was in the making, these engines were in average operators' hands, being tested in climates from sub-freezing to tropic heat, and in services ranging from heavy to light duty, both industrial and automotive. Every test or service condition that could be imposed by users was applied to prove them in advance.

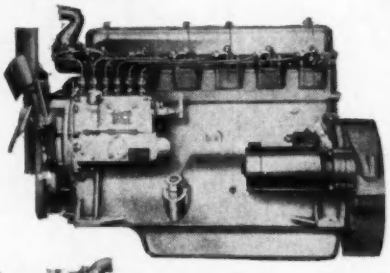
The 4 Waukesha Diesels shown are now ready. All are built for industrial engines, with the 3 smaller models to be available later as automotive engines, as well. They represent the culmination of more than 40 years of heavy-duty engine building in the gasoline engine field, and 20 years of Diesel research and development.

Consult Waukesha engineers on *all* your engine needs. Write for information.

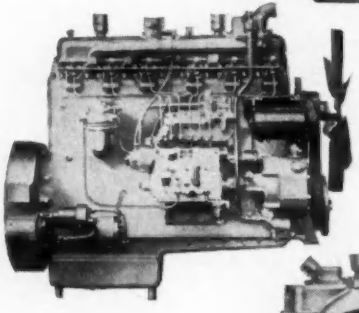
WAUKESHA DIESELS
FOR INDUSTRIAL AND AUTOMOTIVE SERVICE



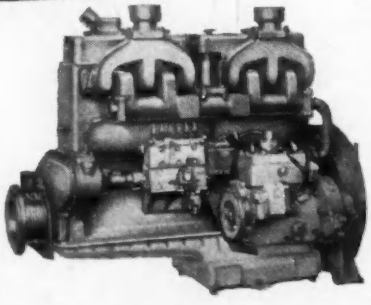
Model 180-DLA
Four cylinders, 3⅜" x 3¾", 134 cu. in. displ.



Model 190-DLA
Six cylinders, 3⅝" x 4", 247 cu. in. displ.



Model 148-DK
Six cylinders, 5¼" x 6", 779 cu. in. displ.



Model 6-WAKD
Six cylinders, 6¼" x 6½", 1197 cu. in. displ.

WAUKESHA MOTOR COMPANY
WAUKESHA, WISCONSIN
NEW YORK • TULSA • LOS ANGELES

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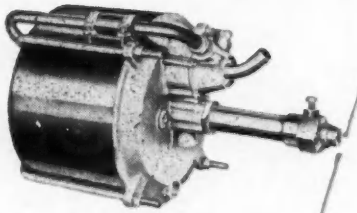
Automotive Vehicles Ever Built have been Better Because of

Bendix Engineering



Hydrovac* scores one more engineering "first" for Bendix. Hydrovac combines in one compact unit all the advantages of previous vacuum power braking systems. With three simple tubular connections, it uses engine manifold vacuum to give smooth, positive brake action with a minimum of driver effort. Already the industry acclaims Hydrovac as "1st in power braking."

The dictionary defines engineering as "the science and art of constructing and using machinery." In no other industry has progressive engineering achieved such outstanding results as in the automotive industry. Bendix* has been the partner of this progress for over thirty years, and has always held a prominent place in the vanguard of new engineering development. Tomorrow, as in the past, the industry can confidently expect the *best* from Bendix—First in Creative Engineering.

*REG. U. S. PAT. OFF.

BENDIX PRODUCTS DIVISION OF
SOUTH BEND 20, IND.

Bendix AVIATION CORPORATION

HYDROVAC* POWER BRAKING
B.K.* VACUUM POWER RELAY VALVES
TRAILER VACUUM POWER BRAKES
HYDRAULIC POWER STEERING

Bendix PRODUCTS DIVISION

WHEEL BRAKES
CENTERMOUNT PARKING BRAKE
HYDRAULIC REMOTE CONTROLS
UNIVERSAL JOINTS

SAE 1947 ANNUAL MEETING

Sets New Records

SAE's 1947 Annual Meeting was a record-breaker. Held as usual at the Book-Cadillac Hotel in Detroit, Jan. 6-10, it set new highs in total attendance, attendance at technical sessions, size of Annual Dinner audience, number of technical sessions, number of papers presented, and number of committee meetings and committee attendance. For the first time it was a three-ring circus – literally. Three technical sessions were going on simultaneously nearly every day of the gathering. Each one of SAE's 11 Professional Activities was represented by one or more sessions.

Distinguished speakers from the top ranks of Government and industry – and from every important echelon of automotive engineering – brought ideas, facts and stimulation to the 6000 members and guests who attended the 30 sessions. Topping the list was Secretary of Commerce of the United States W. Averell Harriman, who was principal speaker at the Annual Meeting Dinner. Studebaker President Paul G. Hoffman was toastmaster at the Masonic Temple gathering where an audience of 3500 was seated when Detroit Section Chairman Vincent C. Young opened proceedings by welcoming the members to Detroit and introducing Hoffman.

L. Ray Buckendale, SAE president for 1946, and 1947 SAE President C. E. Frudden preceded Harriman as speakers.

Frudden Stresses Tractor Achievements

Expressing appreciation for the honor accorded him, Frudden stressed the efforts and accomplishments of tractor engineers in SAE activities and detailed the ever-increasing part which automotive engineering is taking in farming and agricultural development. "With a record of continuous and healthy growth to look back upon," Frudden said, "the SAE course for the immediate future is felt to be already set, and the new administration, counting on the loyal support of the active membership, can assure the Society bright prospects for the year ahead."

(Frudden's inaugural address will be published in full in the March SAE Journal.)

"SAE Is Unfinished Business" – Buckendale

Reviewing the work of SAE during the year of his administration and pointing to problems still ahead, Buckendale voiced specific gratitude that SAE definitely is unfinished business. He said in part:

"There is, in the field of cooperative engineering, so much to be done by and through SAE that the first half-century of this Society seems in retrospect to be merely a warming-up period for tremendous accomplishment. SAE achievements in the future are likely to be both expansive and accelerated. . . .

"The individual engineer looms large upon the SAE scale of importancy. There is, about our Society, an aura of fraternalism which creates an environment favorable for the growth of the individual engineer, and for the ultimate flowering of his ideas, theories, principles, practices, and projects.

"In this age of great accumulations of research

and development talent, the individual really needs the SAE environment. And engineering needs the individual. . . . "

Progress Plus Stability Is American Aim, Says Harriman

In America, as abroad, there is an increased desire for stability, Harriman warned his audience. But there is a difference. We aren't willing to trade opportunity for security. The British and Europeans are. . . . There is considerable thought in England that opportunity and progress should be secondary to stability. . . . They are willing to forego considerable progress for plans which they think will attain stability.

Americans are challenged, he said, to develop an economy which gives both security and opportunity for progress . . . and we are the only country with ability and resources to do it at the moment, in the Secretary's opinion.

Our success along these lines will greatly influence the course of events in other countries, he stated. Our success would give encouragement. It would be an example to people of other countries to retain the maximum values of free enterprise and personal freedom.

Granting that we cannot eliminate all economic fluctuations, Harriman stated categorically that "we can avoid serious depressions." He thinks we can reduce the big swings in business activity and give the individual security against personal economic catastrophe.

He urged that automobile prices be held to a minimum and that the automobile industry give special support to Government policies to further sound import programs designed to break down trade barriers.

"With the great power of the American economy," he contended, "we have a unique opportunity to help other nations to help themselves. The world desires, not only American goods, but American engineering and American techniques. Industrialization of backward countries has increased their participation in world trade and enlarged markets for American exports.

"American free enterprise," he concluded, "has a great opportunity to take leadership in expanding world prosperity. We have tremendous opportunities at home and abroad. America has always seized its opportunities even though the road has not been easy. Let's not forget that there have always been pebbles in our shoes. As C. F. Kettering says: 'Lets not let them stop us from going ahead.' "

New SAE President, Predecessor

1946 SAE President L. Ray Buckendale (right) with 1947 SAE President C. E. Frudden

Life Membership Awarded to James at Business Session

SAE Past-President W. S. James was awarded a life membership in the Society, the presentation being made by SAE President L. Ray Buckendale at the Business Session on Tuesday evening. Election of members-at-large to the National Nominating Committee was the only business transacted.

■

The 94 authors and co-authors of 63 papers, together with scores who entered the discussions at the 1947 Annual Meeting, represented 64 corporations or their divisions, the military services, several other Government agencies, and many colleges and universities.

Four General Motors Corp. divisions were represented by one author each; four speakers came from Thompson Products, Inc.; four were NACA specialists, and four were technicians from Ford Motor Co.

The Air Materiel Command of the AAF sent three authors (including a major-general) as did the Navy.

Companies represented by three authors each were Bendix Aviation Corp., The Texas Co., and United Aircraft Corp.

The president of Packard Motor Car Co. and one of his engineers spoke at different sessions. Two engineers each also contributed techniques developed by Willys-Overland Motors, Inc., Boeing Aircraft Co., American Airlines, Inc., Trans World Airlines, Universal Oil Products Co., Sperry Gyroscope Co., Consolidated Vultee Aircraft Corp., Union Oil Co. of Calif., Glenn L. Martin Co., the National Bureau of Standards, and Caterpillar Tractor Co.

One speaker each represented a total of 35 other manufacturers, airline operators, petroleum refiners, and the CAA – and three authors were consulting engineers, one from England.

Highlights of the various technical areas of the meeting are developed in the series of summary articles based on the papers and sessions which begin on the pages immediately following.

CAR ENGINEERS Explore New Engines, Passenger Comfort

Based on seven papers presented at three sessions on Passenger Cars, under chairmanship of **F. S. Spring, J. G. Wood** and **D. G. Roos**. . . . "The Development of the Skinner Slide Valve Engine," by **R. L Skinner,** Skinner Motors, Inc.; "A New High Performance High-Speed Engine," by **R. M. Heintz,** The Jack & Heintz Precision Industries, Inc.; "Copper Brazed Crosley Motor," by **Paul Klotsch,** Crosley Motors, Inc , "Heating and Ventilation Design Factors in Automobiles," by **L. A. Rodert,** National Advisory Committee for Aeronautics; "Rubber – Will We Make It or Take a Chance?" by **J. E. Hale,** Firestone Tire & Rubber Co.; "How Light Is Light in the Passenger-Car Field?" by **W. D. Appel,** Willys-Overland Motors, Inc.; "Rear Individual Wheel Suspensions – American and Foreign," by **A. M. Wolf,** Consulting Engineer. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in the SAE Quarterly Transactions.

THROUGHOUT the passenger car discussions the price-value relationship was given important consideration. "What will it cost?" was argued side-by-side with "What will it do?" in every phase of the analyses of current and future design possibilities which made up these sessions. Tomorrow's cars will be more comfortable, perform better, and be more economical – but will cost less, rather than more, if implications about future designs are fulfilled.

Unconventional engines were studied for their low cost as well as their added performance features. Advocates of rear-wheel independent suspension warned of cost disadvantages while urging more than offsetting comfort advantages. High volume use of synthetic tires was asked for military security and long-term price stability, despite possible current sacrifices in performance. Light car possibilities for comfort and economy were suggested in addition to low cost as pointing toward greater emphasis on such vehicles . . . and better heating and ventilating for cars was definitely related by speakers to the cost factor in determining its practical availability.

Two new engines, both of which already are in production, were reported by design and production authorities to be giving better performance and fuel economy, yet costing less than present poppet valve types. Maker and designer of the first of these, the Skinner slide valve engine, predicted that its success will revolutionize conventional vehicle design concepts and engine design criteria. Years of cut-and-try laboratory and field tests removed its troubles, he said.

In one test run the Skinner engine was compared with a conventional 8-cyl engine in a 1941 Pontiac. The Skinner engine averaged 18.6 mpg to the Pontiac's 11.8. (Compression ratio of the Skinner engine was 9.51.) The slide valve engine was reported to give high efficiency at all speeds.

Both high volumetric and mechanical efficiency characteristics of this engine make possible a higher horsepower-weight ratio, an important cost-reducing factor. Some engineers estimated that, using the Skinner engine with a horsepower-weight ratio of 1:4, they might lighten their cars 800 lb – at a considerable increase in performance and economy and a reduction in first cost.

Another important advantage claimed is the reduction in cost and weight of the cooling system. With the same rejection of heat to the cooling water, a smaller radiator and fan probably could be used. A smaller capacity cooling fan might conceivably result in a gain of some 5% useful horsepower.

Valve action of this engine was said to be quiet. Even more important is the elimination of valve-sticking problems. Compactness inherent in this opposed-piston design permits use of a short crankshaft to insure rigidity. Production model of this powerplant, being manufactured by Jack & Heintz Precision Industries, Inc., is designed to make possible operation on a low octane fuel at an 8.5:1 compression ratio without detonation.

Contributing factor in the low cost of the second new engine described at this session was said to be its steel stamping construction. Big story of this engine was shown to be the coupling of design ingenuity and production know-how to create a low-cost powerplant with inherent low fuel consumption and high specific power output.

Its cylinder block consists of steel stampings, copper-hydrogen brazed to steel cylinders made of screw machine parts. Weighing only 59 lb bare, and 120 lb with accessories, this engine has a maximum output of 26.5 hp at 5200 rpm and a maximum torque of 35 ft-lb at 3200 rpm. Radical depar-

S. D. Heron (left), consulting engineer, receiving the Horning Memorial Award for "distinguished active service in the field of mutual adaptation of fuels and engines" at the SAE 1947 Annual Meeting. Award was presented by Mrs. Harry L. Horning (center). Walter G. Ainsley (right), Sinclair Refining Co., was chairman of the session at which the recipient presented his Horning Memorial lecture on "The Mutual Adaptation of Aircraft Fuels and Aircraft Engines." (Text of the lecture will be published later in full in SAE Quarterly Transactions)

THE SECRETARY MEETS THE PRESS AT SAE

At a special press conference just before he spoke to 3500 SAE members and guests at the SAE Annual Dinner on Jan. 8, Secretary of Commerce W. Averell Harriman said: "If we are successful in attaining stability with free enterprise, our success will have a great influence on the course of events in other countries."

ENGINEERING DISPLAY was full of interesting products and ideas.

Forty-nine companies were represented at this year's Annual Meeting Engineering Display: Aeroquip Corp., Aircraft Screw Products Co., Inc., Aluminum Co. of America, Aluminum Industries, Inc., American Bosch Corp., Bakelite Corp., Bendix Aviation Corp., Bostrom Mfg. Co., Cleveland Graphite Bronze Co., Continental Motors Corp., DeLuxe Products Corp., Detroit Diesel Engine Division, GMC, Detroit Gasket & Mfg. Co., Diesel Engineering & Mfg. Corp., Ex-Cell-O Corp., FabriSteel Products Co., Flex-O-Tube Co., Fram Corp., Garlock Packing Co., Gemmer Mfg. Co., General Tire & Rubber Co., Haskelite Mfg. Corp., Hayes Industries, Inc., Hercules Motors Corp., Koppers Co., Link Engineering Co., Lisle Corp., Lord Mfg. Co., McQuay-Norris Mfg. Co., Monroe Auto Equipment Co., Petroleum Advisers, Inc., Physicists Research Co., Pierce Governor Co., Skinner Purifiers, Inc., South Chester Corp., Sparks-Withington Co., Spencer Thermostat Co., Spicer Mfg. Corp., Stewart Warner Corp., Tinnerman Products, Inc., Torrington Mfg. Co., Truck Equipment Co., Inc., Tubing Seal Cap Co., Van der Horst Corp. of America, Vickers, Inc., Victor Mfg. & Gasket Co., Waukesha Motor Co., Witco Chemical Co., Zollner Machine Works.

SAE President L. Ray Buckendale (right) as he presented a life membership in the Society to 1944 President W. S. James

Skinner, Jack & Heintz, and Crosley engine parts were among the numerous exhibits provided by authors at the 1947 Annual Meeting

INDUSTRY'S EXECUTIVES WERE HONORED GUESTS AT BANQUET

Left to right: K. T. Keller, president, Chrysler Corp.; Secretary of Commerce W. Averell Harriman; Ernest Kanzler, chairman of the board, Universal C.I.T. Credit Corp.; and Paul G. Hoffman, president, Studebaker Corp.

Left to right: V. C. Young, Detroit Section chairman and chief engineer, Wilcox-Rich Division, Eaton Mfg. Co.; C. T. Ruhf, president, Mack Trucks, Inc.; Walter F. Rockwell, president, Timken-Detroit Axle Co.; T. R. Lippard, president, Federal Motor Truck Co.

Left to right: Major-Gen. L. C. Craigie, chief, Research & Development Division, U. S. Army Air Forces; M. P. Ferguson, president, Bendix Aviation Corp.; O. E. Hunt, executive vice-president, General Motors Corp.; and Henry J. Kaiser, chairman of the board, Kaiser-Frazer Corp.

Fred M. Zeder, vice-chairman of the board, Chrysler Corp.

Left to right: W. W. Kellett, president, Kellett Aircraft Corp.; Carl Breer, director of research, Chrysler Corp.; and Owen R. Skelton, director of engineering, Chrysler Corp.

Left to right: A. W. Phelps, president, Oliver Corp.; William S. Knudsen, chairman of the board, Hupp Corp.; and C. J. Reese, president, Continental Motors Corp.

ture from conventional design and fabrication of components interested many for its low manufacturing-cost merits.

Making possible the light weight, high compression ratio (7.5:1), and high specific output is the unique cylinder block construction – light-gage sheet steel stampings. Exhaust ports are stamped in halves and joined by brace lock seams to form a port for each cylinder. Valve guides are pressed into exhaust and intake ports. After forming intake and exhaust port holes, spark-plug holes are pierced. Tungsten-vanadium alloy steel valve seat inserts are pressed into the exhaust and intake ports after these parts are assembled to the cylinder head.

It was reported that the new Crosley car powered by this engine is recording fuel consumptions of 50 mpg at 30 mph and 35 mpg at 55 mph. Although recommended top speed is 65 mph, the car has been driven at 70 mph with the engine turning over at 6300 rpm.

These lightweight engines pointed up the idea stressed by one passenger car engineer and felt by many that, "If automobile manufacturers are to bring the passenger car within reach of many more millions of Americans, they must build lighter, more efficient, and more economical cars. Not only will this benefit industry at home, but it will prevent losing foreign markets."

Opinion was expressed that light American cars can be built without sacrificing comfort and conventional size, retaining at the same time good acceleration and smoothness. Several methods for cutting both weight and cost were pointed out.

Vehicles can be made smaller, it was urged. If that perturbs the designer, he was told to ask himself this question: Have we the best possible seating arrangements for the maximum number of people in the projected plan area of today's cars? Smaller vehicles will save more weight than money since material quantity is reduced, but labor and tooling costs are not greatly affected.

Elimination of unnecessary parts was highly recommended for saving material and labor without impairing commercial appeal. Designers can be simplified. This step would eliminate unnecessary machining operations, reducing in turn labor costs

as well as investment in machinery and tooling. One approach pointed out was the combining of several functions in a single part, such as the trunk lid handle and the lock and license plate lamps. Higher stresses might be used provided they remain within safe limits. Merit of this technique is the saving of weight without affecting other characteristics.

Light Alloys Reexamined

Much publicized use of light-alloy metals received attention. In one experimental car with aluminum body parts including doors, 100 lb was saved at a cost of $15 or $16. But these light materials require new techniques and were said to involve further cost increase to cater to their different characteristics. Whether the public will pay the price for light alloys will decide the issue.

Design engineers were advised that achievement of lightweight cars requires subordinating the aesthetic to the functional. Greatest potential weight saving lies in the body; it's the heaviest single unit and a relatively low-stressed structure. Its trim and garnishing contain a high percentage of nonworking material.

Cost versus comfort carefully was weighed in sessions on the third day. It was argued that comfort features such as heating and ventilating loom as a competitive selling point and that public demand for comfort – at a reasonable price – will accelerate this trend.

Commercial airline technique of achieving high airconditioning standards was proposed as a goal for passenger car engineers. Important point made here was the need for designing the airconditioning system into the car for best results and lowest costs. (See article entitled "Car Heating Pattern Set by Plane System" on p. 78 for detailed discussion of this paper.)

Whether the price is worth the comfort was a matter of conjecture in individual rear-wheel suspension discussions. By reducing unsprung weight, this type of suspension gives a smooth ride, especially on off-the-highway driving. But it costs more both to build and maintain than solid axle types.

Individual rear-wheel suspensions were demonstrated to minimize severe reactions on the frame and body over rough terrain. A high roll center, reducing roll moment and passenger discomfort, is readily attainable in certain of these designs.

One type, the swinging axle, was reported to give lighter unsprung weight, permitting the wheel to follow road contours more closely. It also reduces wheel spinning and tread chafing. Although this design gives varying camber and tread, European experience does not indicate undue tire maintenance. Experience with a Willys-Overland design of this type proved tire mileage was better since the wear is more even with a round tread than with a flat one. Tire structure provides this system with an inherent damping effect – impact is absorbed right at the point of initiation.

On the debit side of the individual suspension picture were shown to be (1) greater fabricating costs, (2) higher assembly costs because more parts are involved, and (3) possible shorter life of parts such as universal joints and wheel mountings. "Will the customer pay for ride comfort?" is the $64 question.

Key to demands for better performance from a cheaper tire were shown to be held by synthetic rubber – only if automotive engineers would do some long-range thinking and support synthetic rubber development and production. Good business sense and national security were said to demand it.

Buying natural rubber from foreign sources has taxed industry's and the public's pocketbook because we no longer have a free market. The British and Dutch cartel was shown to be controlling world rubber prices with an iron hand. Based on prewar natural rubber prices of 18 to 20¢ per lb, using synthetics will net the consumer a saving. (Price of GR-S used in tires was forecast at about 15 or 16¢.)

Technically as well as economically industry eventually will benefit from using synthetics. While natural rubber still has the edge on synthetics from an engineering standpoint, new developments are closing this gap. Most important shortcoming of the man-made product was said to be greater heat build-up. In city driving this is no problem; but in high-speed cross-country driving in hot weather, synthetic tire temperatures are 15 to 20 degrees higher than in all-rubber tires. This slightly increases the tendency for the cord body to weaken and blow-out or separate.

Synthetic Prospects Bright

But it was felt that man-made rubber know-how is still in its infancy and that technologists are on the threshold of discoveries in this field that will elevate the test-tube creation to a competitive level with nature's product.

From the standpoint of national security, the present synthetic rubber situation offers a bright picture. We no longer need depend on foreign sources for so vital an element in the modern war machine. Only by maintaining sufficient synthetic productive capacity can we insure against crisis in event of attack.

Industry was told that it must not permit disintegration of this country's $700,000,000 synthetic plant investment. "If large car manufacturers in particular fail to do what they can to maintain a balanced use of natural and synthetic, there can be a grave risk of bringing about a situation which in the long run would not be to their advantage," warned a prominent executive.

T&B, T&M, BODY Sessions Focus On Better Vehicles

Based on: Two papers presented at two sessions on Transportation and Maintenance, under chairmanship of **M. E. Nuttila** and **D. K. Wilson** . . . "Energy Dissipators Auxiliary to Brakes," by **J. G. Oetzel,** Warner Electric Brake Mfg. Co.; "Two-Way Radio Telephone Suitable for Automotive Fleet Application," by **W. C. Baylis,** N. Y. Power & Light Corp. . . .

Two papers presented at one session on Body, under chairmanship of **T. L. Hibbard** . . . "Modern Coach Structures," by **H. E. Fox,** GMC Truck & Coach Div., General Motors Corp.; "Something Old and Something New in Automotive Plastics," by **Fred B. Stanley,** Modern Plastics Magazine . . .

Four papers presented at one session on Truck and Bus, under chairmanship of **L. W. Fischer** and **B. W. Keese** . . . Designing for Higher Output in Gasoline Engines – "Considerations in Valve Gear Design," by **V. C. Young,** Wilcox-Rich Division, Eaton Mfg. Co.; "Superchargers for Gasoline Engines," by **R. L. Weider,** White Motor Co.; "The Trend in Combustion Chambers and Fuel Systems," by **A. T. Colwell,** Thompson Products, Inc., and **Alex Taub,** Consulting Engineer to Thompson Products, Inc.; "An Approach to the Selection of Compression Ratio as Related to Fuel Quality," by **E. J. Gay** and **H. T. Mueller,** Ethyl Corp. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in the SAE Quarterly Transactions.

FROM start to finish of all sessions involving commercial vehicle builders and operators could be heard the theme of cooperation. Despite the many phases of vehicle design and operation covered, emphasis was largely on harmony, understanding and appreciation among producers and users of each other's problems.

How cooperation through the medium of SAE technical committee activity is evolving two-way radio for fleet operation started the meeting on a positive note. Later considerable light was thrown on solution of braking and allied problems through use of energy dissipators supplementing wheel brakes.

From the manufacturer's side of the fence came encouraging answers to the operator's persistent plea for greater operating economy. Here the engine builder, parts manufacturer, and fuel supplier demonstrated their efforts towards lightening the user's burden.

One engineer promised that improved valve design will make maintenance men (and the engine) hum a brighter tune. A trio of engineering developments – superchargers, better combustion chambers, and compression ratios mated to fuel antiknock quality – joined valve improvement in promising aid toward more-miles-per-gallon.

Body technicians were reported as subscribing to a new structural philosophy – too strong a structure can be just as unsafe as one that's underdesigned. Peculiarities affecting vehicle safety at high speeds were pondered by a renowned British authority on the subject.

Even aesthetics and the role of plastics in motor vehicles were not overlooked. Not only were good looks shown to be an outstanding virtue of plastics, but longer life and lower costs were said to be catapulting plastics from the chemist's test tube into present-day cars.

Value of producer-user cooperation to industry was illustrated by a report on how an SAE technical committee is making possible effective two-way radio installations for automotive fleets. This committee's work in showing proper vehicle modifications and considerations for two-way radio took on added importance in the light of hundreds of new installations reported at the meeting.

Greyhound and other inter-city bus lines are equipping their coaches with two-way radio throughout the west, mid-west, and south. A Chicago fleet operator already is dispatching his pick-up and delivery trucks by two-way radio and reported considerable savings in time and more effective use of his fleet. The Detroit police department expressed satisfaction with the equipment. Telephone company representatives advised of mounting interest from other sources such as doctors and taxicab operators.

Such increased use may eliminate some of the present problems. The SAE committee found that locating space for these units is difficult because they are not standardized and because location of available space varies with different vehicles. Adapting the car or vehicle to two-way radio at the factory will not only simplify this problem, but also reduce installation costs. It will eliminate dangers such as a mechanic in the field weakening the structure by drilling a hole at a critical point.

From a bus operator came a revelation that may solve the antenna problem. (Antennas for 40-megacycle frequency must be 70 in. high.) He found it practical to have the antenna lifted by an automatic air-operated device when the operator picks up the hand set. On replacing the hand set, the antenna automatically is lowered and lies parallel

to the coach. Apparently the antenna can receive in a horizontal position so that the system is effective.

Power supply also was shown to be an important consideration in two-way radio installations. Operating experience indicates that, for cars and light trucks, a generator with a capacity 20% greater than total operating load is capable of delivering maximum output at normal vehicle operating speed.

Two-Way Radio Tested

Field tests in which two-way radio equipped cars in Detroit streets were contacted directly from the meeting room disclosed some problems of two-way radio operation. It was shown that sending from open areas gives clearer reception than sending from streets surrounded by high buildings; that the higher the antenna, the better the reception; that high structures shield the signal. A three-way conversation between two moving cars and the fixed station pointed out the flexibility possible with this equipment.

Fleet operators concerned with creating a more favorable balance between revenue and rising costs were shown that energy dissipators auxiliary to brakes may solve a number of their problems. They were advised that this device will permit more trips per year because faster speeds are possible, and maintenance costs also will be reduced.

The eddy current type of dissipator or retarder is geared directly to the propeller shaft. By converting the torque into electrical energy and dissipating it in the form of heat, the vehicle is retarded. Excitation and control of the dissipator is maintained by a generator, independent of the starting and lighting system and the electrically operated brakes. The retarder cuts in automatically at certain speeds – which can be adjusted – and also when the brake pedal is touched or the accelerator is released.

How the retarder can cut schedule time was illustrated in one example. A 45,000-lb vehicle can travel down a 10% grade at 40 mph – provided it can dissipate about 360 hp. With brakes alone, such vehicles are being brought down similar grades, but at slow speeds and considerable wear and tear on transmissions, engines, and brakes. With energy dissipators properly installed and synchronized with wheel brakes, these grades can safely be taken at 45 and 50 mph, with steering as safe as if the road were level.

Interesting information was disclosed on road tests using the retarder. After 2500 miles of operation over mountains and hills, inspection showed that brake linings were not seated and grinder marks were still plainly visible on the drum. Although difficult to estimate, brake lining life using energy dissipators was quoted as being about 200,000 miles. Engine and transmission maintenance also should be considerably reduced. And the retarder itself has no wearing parts except bearings.

Considerable concern was expressed over both the weight penalty and initial cost of such equipment. Present total weight of an installation for a tractor-trailer combination is about 700 lb. Continued development is bringing this figure down. While estimated payload revenue losses due to this added weight varied from 50c to $1.00 per lb per year, one operator pointed out that the additional trips per year made possible by faster descents should more than pay for this revenue loss and the initial cost (not yet determined). He felt that although there is already a tendency in this direction, only a device like the retarder makes speeding-up safe.

Load-shift – another urgent and yet unsolved problem allied to braking – enjoyed serious discussions from both the platform and the floor. In applying the brakes during down-hill travel, the front end may be given more than its share of the load. Sometimes this can be disastrous. Springs may twist, front axles may fail, tractor-trailers may jack-knife. Adjusting the retarder on each axle to take different braking loads can alleviate this to some extent. Another solution offered was the use of a radius rod or its equivalent as a means of increasing front-end brake capacity.

Higher Output Emphasized

Speakers and discussers during sessions on the second day accented design improvements for higher gasoline engine outputs. Operating engineers challenged their design colleagues to pry into a far-from-exhausted area of detail refinement – keys to vastly improved performance.

It was said that engines are akin to the human body; both must breathe to live. If valves permit the engine to inhale and exhale properly, the engine will in turn give good fuel economy, high bmep, and a minimum of down time due to failures.

Most valve headaches were said to stem from lack of refinement in design details. Cited as a case in point was valve seat distortion. Recognizing the source of this problem as uneven temperature distribution suggests several remedies. Cooling the valve, use of corrosion and wear-resistant materials on both valve and seat faces are but a few.

Often full seating of the valve is prevented by formation of deposits on the valve stem and in the guide which act as a wedge between parts. A valve-freeing device was reported as having given instant relief. This is logical since nonrotating valves always leave a gap between the guide and stem that gradually fills with deposits and prevents full seating. Creeping of the valve continuously scrapes off the deposit as the stem constantly is seeking a new position.

Opinion had it that success of sodium-cooled valves in aircraft engines merits serious consideration by heavy vehicle manufacturers. Cooling keeps temperature below the point at which corrosion is accelerated and results in better performance for a given fuel. Longer life is also a virtue of sodium-cooled valves.

Another item advanced as offering improvements in return for refinements is cam design. Experience of many engineers showed that maximum performance can be enhanced by increasing the overlap. It improves scavenging and increases charge density, resulting in higher bmep.

Oscillograph studies were highly recommended as a method of learning about valve motion and cam characteristics. But unless a high degree of accuracy is attained in cam manufacture, countless hours of design calculations and experimental studies are wasted.

Superchargers and Economics

Supercharging was described as a means of trying to get results of a large displacement engine with one of small displacement. Engineers said the case for supercharging must rest on economics: if cost of the gadget and heavying up of the engine plus maintenance is not more than balanced by increased performance, supercharging will not be adopted by fleet operators.

Although supercharging is producing some beneficial results, it is not without its headaches at this stage of development.

A highly important characteristic of supercharged engines is that fuel consumption remains fixed through a wide operating range at the same values obtained at full throttle of a normally aspirated engine. This is of interest in view of poor fuel economy of gasoline engines at part throttle operation. In one case, a 3-lobe Roots supercharger with a boost pressure of 9½ in. of hg increased the output of a 318-cu in. engine from 113 hp to 157 hp. Specific fuel for all speeds from 1600 to 3200 rpm remained the same.

Selection of the supercharger – centrifugal or the positive displacement type – was pointed out as one of many problems. Centrifugal superchargers give a wide range of air flow with relatively small pressure change for a given speed as compared with the Roots. But the centrifugal supercharger gives a higher temperature rise and thus requires a higher octane fuel for the engine.

Productionwise, the Roots type is not feasible. It requires a large number of gadgets to produce optimum results and these complications are difficult to simplify. It was felt that the centrifugal design can more easily be adapted.

To withstand higher outputs and resulting temperatures without failing, the engine itself must be made more rugged. Connecting rods and main bearings must have sufficient capacity; pistons must minimize distortion from increased pressures and temperatures; head gaskets must permit maximum life; radiator capacities must be increased. Even spark-plug characteristics have been observed to change under supercharged conditions.

Some engineers felt that perhaps a cheaper and less troublesome way of getting more air into the engine is by improving valve design. Not until this work is fully exploited, they said, should the industry go to the extreme of supercharging.

Trend in future combustion chamber design for greater output was said to be contingent largely on the availability of higher octane fuel. As fuel improves in octane number, compression ratios gradually will increase up to about 8:1 for small engines and about 7:1 for large engines.

But with higher compression, it was felt that combustion chamber deposits will be more troublesome. Proper cooling was advanced as one way of lowering quantity and density of these deposits. Cooling also was considered important in preventing local hot spots and controlling detonation. But the other problem of high compression – shock caused by a coupling of a sufficient burning charge and a high rate of pressure rise – will call for increased engine rigidity, improved bearings, and generally heavier redesign in the lower part of the engine.

Future engine design trends will take off from the three types now being favored by industry – valve-in-head, L-head, and F-head. Changes to be made, many experts felt, will be refinements such as in cooling, induction and exhaust systems, pistons, and sparkplugs.

Valve Layouts Reviewed

Exponents of the valve-in-head engine quoted advantages of this design as being freedom from breathing resistance, high degree of flexibility in shaping the combustion chamber within physical spaces, and relief of heat-stressed elements in the cylinder block. This arrangement was claimed to show better economy and power than the L-head for compression ratios above 7:1.

Those engineers who believe compression ratio increase will be slower than anticipated because of such problems as intake valve and manifold varnish, felt that L-head engines will remain in use for some time to come. They offer ease of maintenance and simpler valve mechanism.

Arguments in favor of the F-head design included high volumetric efficiency, good combustion control and cooling. It was said to have desirable antishock and antiknock characteristics. Several F-head tank engines built during the war attained unusual efficiencies.

Looking ahead in fuel systems finds many engineers still hoping for a simple, moderate cost fuel injection unit. It will undoubtedly improve distribution and power output of large engines. An-

other form of injection that is proving its value, but for an entirely different purpose, is alcohol-water injection. Much was claimed for it in cooling engines running over-hot. Alcohol-water injection does not promote corrosion, as some believe, since it is injected only at high temperatures whereas corrosion occurs at low temperatures.

Petroleum technologists told engine designers awaiting high octane fuels that octane number should not be the sole criterion in aiming for greater outputs. Fuel sensitivity (difference between Motor method and Research method octane numbers), spark advance, and compression ratios all must be matched to each other to best achieve increased performance.

Motor gasolines being produced are more sensitive than their prewar predecessors due to the advent of catalytic cracking. Since Motor and Research method ratings no longer are true indexes of fuel performance, the Borderline method was adopted. It considers the influence of engine speed and spark timing on gasoline antiknock quality.

Laboratory results using this method were said to compare well with actual road performance.

In these tests, using a high antiknock development fuel, variation of full torque and specific fuel consumption with ignition timing are obtained at 200 to 400 increments. Range of spark advance surveyed at each speed brackets the timing for Borderline knock at the lowest octane number expected to be used.

With the data from these tests, a Borderline curve is obtained showing graphically a fuel's ability to tolerate spark advance throughout the engine speed range.

An important disclosure, particularly for engine designers, resulting from tests of this type on several engines is that a compression ratio of 7.3 plus a certain spark advance (depending on the fuel) is the best compromise for gasolines in the antiknock quality range of 72 Motor-77 Research to 81 Motor-86 Research. Coupling the 7.3:1 compression ratio with the proper spark advance was reported to give the least loss in brake horsepower and specific fuel over the full engine speed range.

From the field of body engineering came fresh thoughts recently hatched in industry's laboratories. New concepts in structural strength and trends in plastics opened vistas (and technology's eyes) to safer and more economical body engineering. It was shown that there is an optimum safety factor in a motor coach structure beyond which injury to passengers, in event of collision, will increase instead of decrease.

Reason for this was explained by examining the two sources from which injury stems during collision – (1) failure or collapse of the structure, generally localized in the region of impact and, (2) violent catapulting of passengers and driver from their seats against obstructions in front due to high decelerating forces.

The higher collision resistance, the greater the decelerating forces tending to throw passengers forward. If the structure withstands a force four times the coach weight, each passenger – in collision – will be thrown with a force four times his own weight.

In the ideal structure these forces would be in a ratio resulting in minimum injury to passengers. Designers were advised that injuries from crushing the structure are generally localized and affect only a few passengers. But high crush resistance promotes decelerating forces, jeopardizing all the passengers and the driver.

A plea from the plastics industry for greater harmony and understanding from automotive interests emphasized the mutual benefits of such a plan. It was shown how discord in the past handicapped plastic application and how working hand-in-hand now is speeding use of plastics.

Typical of early misunderstandings cited was "The Case of the Shrinking Speedometer Lens." One automotive company placed a contract with a molder for domed 6-in. diameter lenses. Despite warnings from the molder of shortcomings of the material he was instructed to use, he was ordered

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Two-Way Radio Shows Promise as Transport Aid

Field test of two-way radio installed in two automobiles was a feature of the opening day's program. Directed from the meeting room (as shown above) where Wesley C. Baylis, N. Y. Power & Light Corp., reported conclusions of more than a year's committee work, the tests were arranged to show the practicability of this equipment in fleet operation.

The broadcast station was on the 29th floor of the Book-Cadillac Hotel – with an antenna on the roof. Another station at Belle Isle was used alternately to show the difference between broadcasting from an electronically noisy station, such as one in the center of a city, and from a quiet station, such as the Belle Isle one which serves the Detroit Police Force.

Arrangements for the test were made by Baylis with the cooperation of the Detroit Police Department, Detroit Edison Co., Belmont Division, Raytheon Corp., and Radio Corp. of America. The test illustrated technical points presented in Baylis' paper.

Sections Committee Changes Chairman

R. F. Steeneck (left), 1946 Sections Committee chairman, has been elected an SAE Councilor to fill the remainder of the 1946-1947 term of C. E. Frudden, who resigned to become SAE president for 1947. Steeneck, who was an SAE Councilor for 1944-1945, is shown here with R. J. Waterbury, who takes over the Sections Committee chairmanship for 1947.

The designer of the world's fastest automobile and the man who drove it to the 369.7 mph record were featured guests at the Monday evening session sponsored jointly by the SAE Body Activity and the Junior Student Committee of the Detroit Section. Here they are – left to right – John Cobb, the driver, Reid A. Railton, the designer, Detroit Section Chairman V. C. Young, and Capt. George E. T. Eyston, who held the record before Cobb took over in 1939.

At the session, SAE Past-President D. G. Roos, vice-president, Willys-Overland Motors, Inc., sparked the proceedings as questioner to Railton, who announced that Cobb would have a try at boosting his own record on the Bonneville Salt Flats about next August. B. B. Sneed and F. S. Spring were co-chairmen of the session.

Answering questions by Roos, Railton said that the record-holding vehicle, dubbed the Red Lion, is powered by two Napier aircraft engines built 20 years ago. One engine powers the front wheels and the other the rear wheels. Each has a displacement of 1430 cu in. and delivers 1350 hp at 3700 rpm with 10-12 psi of supercharging. Fuel is mixture of aviation gasoline, methanol, and benzol.

Another of Railton's achievements is the racer powered by a 45 cu in. engine that reached a speed of 160 mph. It is the fourth fastest car in the world and the fastest in its class. The engine delivers 170 hp at 8000 rpm with supercharging of about 25 psi.

On sea as on land Railton's designs hold speed records. The motor boat designed by him for Sir Malcolm Campbell skims the water at 142 mph. Railton feels that the propeller and screw must be replaced by the old-fashioned paddle wheel if boat speeds much greater than this figure are to be attained.

to proceed with it. Shortly after cars with these lenses reached warm climates, the lenses curled up and fell to the floor. After arguing many weeks over who was to blame, the molder finally convinced the car manufacturer that another material would fill the bill.

Such occurrences were reported to be gradually disappearing. For example, Briggs Mfg. Co. has for several years been working with the plastics industry on development of phenolic resin-impregnated paper. Used as door panels, this laminated plastic sandwich shows greater scuff and wear-resistance than conventional materials. Decorative plastic laminates not only do a better job, they are cheaper.

Designing for super-speed record-breaking race cars was said to be for sake of sport only, although by-products of this experience may aid passenger car designers.

Engineers were told that streamlining at 370 mph produces odd secondary effects. Center of pressure is moved far forward, ahead of the car's nose, making the vehicle highly susceptible to side winds. Even more important than the additional

speed made possible by streamlining, it was pointed out, is the increase in acceleration it gives – in the order of 20-25% for speeds of 70-80 mph.

Rolling resistance was earmarked as another significant factor to contend with at high speeds. In the 6 mpm range, it can consume as much as 25% of engine output. In this respect, tires play an important role. As the tire starts to disintegrate, rolling resistance increases enormously. High tire inflation at these speeds appears to keep rolling resistance to a minimum, according to field test results reported at the session.

Jets and Injection Open New Areas in POWERPLANTS

Based on 13 papers presented at six sessions on Aircraft Powerplants, under chairmanship of **M. J. Kittler, C. T. Doman, F. W. Godsey, E. A. Ryder, R. W. Young,** and **Robert Insley.** . . . "Fuel Metering by Engine Speed and Manifold Density," by **J. A. Bolt,** Bendix Products Division; "Fuel Injection Systems for Light Aircraft," by **G. M. Lange,** Ex-Cell-O Corp.; "Crankshaft Bending Vibration," by **E. F. Critchlow,** CAA, and **W. T. Bean, Jr.,** Continental Aviation & Engineering Corp.; "Propeller Requirements for Light Aircraft," by **J. F. Haines,** Aeroproducts Division, GMC; "The Atmosphere and Its Predicted Effects on Turbine Type Aircraft Engines," by **A. Dolinsky** and **F. W. Disch,** Boeing Aircraft Co.; "Study of Fuel Systems for Jet Aircraft," by **W. H. Curtis** and **P. J. Lansing,** Thompson Products, Inc., "O-Ring Seals in the Design of Hydraulic Mechanisms," by **D. R. Pearl,** Hamilton Standard Propeller Division; "Mean Specific Heats for the Working Media of Gas Turbine Powerplants," by **N. A. Hall,** United Aircraft Corp., "Stresses in Rotating Discs by Radius of Curvature Integration," by **C. M. McDowell,** Packard Motor Car Co.; "NACA Study of Measurement of Piston-Ring Radial-Pressure Distribution," by **M. C. Shaw, C. D. Strang,** and **O. W. Hart,** NACA; "Engineering and Research Planning of the Army Air Forces," by **Major-Gen. L. C. Craigie,** Air Materiel Command; "Cold Weather Operation of Aircraft Powerplants by the U. S. Navy," by **A. K. Forney,** Navy Department, Bureau of Aeronautics; "Aircraft Engine Starting Tests and Experiences in the Arctic," by **William Weitzen** and **R. G. Dunn,** Air Materiel Command, and "Cold Starting Characteristics of the Cyclone Engine," by **G. A. Bleyle,** Wright Aeronautical Corp. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in the SAE Quarterly Transactions.

PLANS for a gigantic Army Air Forces Engineering Development Center to provide military, Government, science, and industry alike with facilities for solving the aerodynamic, mechanical, and physical problems attending the search for aircraft, engines, and equipment to operate at transsonic speeds and stratospheric altitudes were disclosed by Major-Gen. L. C. Craigie, engineering chief of the Air Materiel Command. As if in partial answer, engineers of Government agencies and of industry described their present progress in solving some of the detailed problems arising in their development of the little-understood turbine engine as well as the better-but-still-not-perfectly-understood piston engine.

AAF Research Program

General Craigie described the proposed Development Center as part of a gigantic research program looking to production of transport planes capable of moving entire divisions of ground troops, of combat planes flying 500-600 mph, and of instruments for obtaining meteorological data from altitudes of 600,000 ft.

Some aircraft are already nosing into the transsonic speed ranges, he said, while pilotless aircraft and guided missiles are headed for supersonic speed applications. He added that in this upper realm of flight, problems become really complex, for air no longer acts as air, but takes on the characteristics, first, of a semifluid, and then of a fluid. To design aircraft to fly in such media is, he related, quite an assignment. He remarked, "We stand about where the Wright brothers stood when they were contemplating their first flight some 40-odd years ago."

Among other current projects, he said, is the recently tested XS-1 rocket plane – a flying laboratory for studying flight and design research problems at transsonic and supersonic speeds.

General Craigie expressed the belief that future war will be global, and equipment must be operational under all geographical and climatic conditions, with the possibility of going from one extreme condition to another in a few hours.

Winterization of Aircraft

Current knowledge of operation under extremely low temperatures is still limited and great emphasis is being placed, he explained, on the winterization of aircraft and equipment. One phase of this

problem, cold-starting engines under arctic condition, was the subject of a symposium that included speakers from Army, Navy, and industry.

These speakers agreed that it is now possible to start engines promptly in temperatures to —65 F – as required by both Army and Navy specifications. It developed that the chief work still to be done is in simplifying equipment and procedures.

The Navy was reported to be particularly interested in eliminating as much as possible special equipment and special fuels because of limited space. The Army appears, however, to be willing to put up with a certain amount of special equipment. The difference probably may be ascribed to the Army's need for successful starts at lower temperatures than the Navy.

Thus the Navy would like to eliminate oil dilution altogether, whereas the Army speakers claimed that it is basically a sound procedure and reported that, in fact, it had been the mainstay of arctic engine operation. They said they could find no evidence of engine failure that could be attributed to *proper* use of oil dilution, asserted further that it actually lengthens engine life under these conditions.

The Navy was reported to be eliminating heaters rapidly. In this trend the Army was in agreement. Army speakers disclosed that heating is regarded as dangerous practice unless used in conjunction with dilution. It was explained that while heating makes an engine crankable, it does not customarily thaw out oil lines, tanks, and coolers, with the result that there is inadequate flow of oil.

Army and Navy disagreed as to the use of special volatile fuels for starting. The Navy again wanted the simpler procedure of being able to start without a special fuel; looking forward, instead, to improvements in the priming system that would eliminate the need for such fuels. The Army speakers, on the other hand, recommended the use of special fuel, suggesting normal butane until improved priming systems and starting techniques make it possible to use fuels having a vapor pressure of, say, 25 psi.

Utilization of butane was questioned, however, as requiring a complex metering system, and having a narrow temperature range for given flow rates, thus aggravating the priming problem. This fuel was said to cause poor idling through overrich mixtures, with the attendant risk of engine stoppage during warmup. It was disclosed that a recently developed special starting fuel gives consistent starts from 10 F down to —65 F and it is believed that its use will greatly simplify the cold-starting problem.

There was general agreement that if a synthetic lubricating oil could be developed with an extremely low pour point, many cold-starting problems would disappear.

From Air Materiel Command's engineering chief came reports that work on jet-propelled rotors is under way in an effort to determine best blade shape, construction, and material, as well as how to overcome the hazards of icing and abrasion.

It was disclosed that a start in this direction has already been made through study of the effects of atmosphere on turbines.

It appears that turbine engines are affected to a greater extent by variations in outside temperature and to a much less extent by high humidity than the reciprocating engine. In determining the thermodynamic characteristics of the fuel-air mixture, it is important to have an accurate figure for the mean specific heat of the air. A new series of charts was said to give the mean specific heat of air, with correction factors for water vapor, fuel vapor, and products of combustion.

The effect of introducing such contaminants into the airflow was discussed in detail. It appears that large amounts of water in the airflow can automatically give large increases in power. Abrasive or erosive matter, on the other hand, may change the physical contour of the blading and clearance, causing a loss in efficiency and indirectly of thrust and power. Oil and dirt were characterized as particularly injurious, for in the later stages, the heat of compression may bake the mixture on the blades, even change the airfoil characteristics.

A simple air intake screen was reported to be sufficient to keep out stones, but exclusion of the finer foreign matter, such as dust, sand, and ice, is a more difficult task. The tremendous volume of air taken in by the turbine type of engine was said to make the use of filters impractical.

It developed that the inertia separator appears to offer a promising solution to this problem, particularly in the troublesome icing phase. It was claimed that inertia separation removes 95% of the water without affecting the ram.

That this matter of contaminants is a serious one can be appreciated from the fact that in an investigation of 300 major overhauls of a German turbojet engine with an axial compressor, 150 cases of damaged compressors were found.

Discussion of the design phase of rotors presented a practical engineering solution to the important problem of determining centrifugal stresses in a rotating wheel. Curves revealed the stress distribution within a wheel, as derived by this method. Point was made that thermal stresses must also be considered; in other words, thermal stresses plus centrifugal stresses must not be greater than the elastic limit of the material at that temperature.

Piston Engines

The reciprocating engine was described as being still the best bet for long-range, substratosphere flight at subsonic speeds, but signs appeared that the propeller-driven gas turbine is becoming its

strong competitor. Designers of conventional engines indicated that they are not unaware of the competition that the new types of powerplants are giving. Hard work is being directed to the task of perfecting the piston engine. Under development is a simple pickup to measure crankshaft-bending vibrations, and another instrument for measuring piston-ring radial pressure distribution.

Study Bending Vibration

Recent crankshaft failures in flight – especially in opposed engines, where the shafts are not too well supported – were said to have made this study of bending vibrations imperative. Research so far has disclosed that the bending vibration characteristics of a crankshaft may vary with the propeller used, so that endurance testing with a 4-bladed club propeller does not necessarily substantiate the safety of a crankshaft design when the flight propeller is used.

It is believed to be possible, however, to evaluate any crankshaft-propeller combination, when the new pickup is brought to perfection, merely by attaching the pickup to the crankshaft, running the engine at operating speeds, and taking readings to determine the critical conditions. A difficulty not yet surmounted was reported as inability to keep the instrument in place for more than a few seconds at a time when the resonant condition is reached.

A specially designed radial-force measuring multipoint gage was also described. With the aid of this instrument, studies of radial pressure distribution in piston rings are being made. It appears that a cylinder out of round by as little as 0.005 in. can affect the radial pressure pattern significantly, and that even a ring exhibiting uniform radial pressure will not necessarily exert equal forces when compressed to cylinder diameter at a finite number of points.

It was claimed that the radial pressure distribution diagram can be correlated with engine performance to determine the most desirable pressure pattern. Thus the pattern provides a valuable criterion of quality in ring manufacture.

Fuel systems are being given a figurative overhauling. The carburetor seems to be on the way out. For instance, a new type of fuel metering system was revealed to be so different that carburetor thought and procedure must be completely forgotten if full advantage is to be taken of the new possibilities.

This development, known as the speed-density system, has actually been applied to engines with timed cylinder injection and to engines with continuous induction system injection. It was reported to be applicable to turbojet engines.

The engine itself is used as an air meter in place of the standard carburetor venturi system. The system consists of an engine-driven fuel pump, centrifugal pressure regulator, pressure-responsive bellows assembly operating a contoured fuel-metering needle, a temperature unit responding to changes in intake manifold temperature, centrifugal vapor venting system, constant-pressure fuel discharge nozzle, throttle-actuated accelerating pump, and air throttle valve for controlling engine power. It was claimed that the device meters the fuel in response to variations in engine speed, intake manifold pressure and temperature, and exhaust back pressure.

The system was said to offer such advantages as increased consistency of fuel consumption in flight, possible reduction in induction system restriction, more direct checking of fuel metering equipment, reduction in size and weight of unit, greater flexibility in installation, and automatic altitude compensation of idling fuel flow.

Also discussed was a fuel system of the intake metering injection type said to be particularly well suited for small spark-ignition aircraft engines because of its compactness, low cost, and reliability.

This system incorporates intake metering of fuel with a mechanical linkage between fuel and air throttle lever arms. Fuel flows from the tank through the supply pump to the metering valve, the amount of fuel being dependent on the supply pressure and the throttle position. The pump throttle is calibrated and linked to the air throttle in the correct relationship to provide the proper amount of fuel for a corresponding metered airflow over the operating range of the engine.

Jet Fuel Systems

Necessity for achieving speed in the supersonic range, Army representatives said, has produced an entirely new array of problems.

New types of powerplants – gas turbine for jet propulsion, gas turbine for propeller drive, intermittent jet, pure ram jet, and rocket motor – have been evolved. But all are still in an early stage of development.

For instance, the fuel system – heart of any engine – is so little understood and so complex that, it was explained, the design of fuel systems for piston engines is elementary in comparison. The jet engine, in effect, demands two fuel systems – an airframe system that includes tanks, control valves, selector and shut-off valves, and an engine system that comprises filters, control units, engine-driven fuel pump, flow dividers, and fuel nozzles – operating under conditions varying in their momentary relative importance.

As if this were not enough, the fuel must be delivered at 5-20 times the pressure needed for conventional engine fuel systems – a fact that adds appreciably to fuel pump and accessory design problems.

Instrumentation, Cold Starting Open New Vistas in Studies on F&L

Based on six papers presented at two sessions on Fuels and Lubricants, under chairmanship of **J. J. Mikita** and **J. C. Geniesse.** . . . Instrumentation – "A Photoelectric Dynamometer Load Control," by **M. R. Clapp,** Lubri-Zol Corp.; "An Instrument for Piston Temperature Measurement," by **A. C. Scholp, G. R. Furman** and **P. A. Binda,** The Texas Co.; "Aircraft Detonation Indicators," by **J. S. Bogen** and **W. J. Faust,** Universal Oil Products Co.; "The Development of Detonation Instrumentation for Automotive Vehicles," by **J. W. Wheeler** and **J. H. Goffe,** Sperry Gyroscope Co., Inc. "Frigid-Air Starting and Operation," by **R. Wayne Goodale,** Standard Oil Co. of Calif.; "Engine Warm-Up with Present-Day Fuels and Engines," **J. G. Moxey, Jr.,** Sun Oil Co. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in the SAE Quarterly Transactions.

Announcement that the cycle of engine-fuels matching was back at the point which could create vociferous disagreement between petroleum and automotive engineers was received dispassionately, as if engineers on both sides of the fence were reconciled to the fact and fully recognized that the situation calls for coordination of fuel volatility characteristics and engine design plus serious mutual consideration of many and varied factors. Among factors to be considered, it was explained, is that a majority of cars now on the road, being equipped with manual chokes, will create an irrepressible market demand for fuels of higher volatility which refiners will find it difficult to ignore. Engine designers were reported also to favor the more volatile fuels, which enable them to keep at a minimum the heat applied to the fuel-air mixture and at a maximum the power output of the engine.

REPORTS of substantial engineering progress in the field of fuels and lubricants, including the development of instruments which detect detonation more readily and accurately than the human ear, were tempered by disclosure that the tail-chasing cycle of matching fuels and engines has returned to a particularly discouraging point.

It appears that widespread wartime construction of petroleum refineries producing gasoline by catalytic cracking has resulted in the prospective production of motor fuels of lower volatility. Results include the possibility that the operators of the nation's older motor vehicles may experience some starting difficulties; design engineers may have to plan their fuel distribution systems for a different type of fuel; vehicles equipped with hand chokes may be in for starting trouble which may pass by those with automatic chokes; and fuels may vary widely in their volatility characteristics.

It appears also, in the opinions of some engineers, that those who have developed instruments for detecting detonation in airlines planes are all dressed up with interesting gadgets, but have nowhere to go except to the laboratory. Reasoning of some minds is that airlines operators are not interested in detonation, either as operational phenomenon or trouble, sufficiently to exchange dollars hard come by for little black boxes of electronics regardless of how promising scientifically the results of installation.

Chilly Outlook

Lowered volatility of generally-available motor fuels was described as likely to cause starting troubles in cold weather, particularly on those antiquated vehicles equipped with hand chokes. Cars with automatic chokes were said to be relatively immune, and possible of further immunization by the installation of "volatility selectors."

Little Black Boxes

The epidemic of instruments for detonation analysis was ascribed to the war and the imperative necessity that warplanes function promptly and efficiently at all times. The instruments were said to provide several methods of obtaining, isolating, amplifying, and measuring detonation signals, and even to filter unwanted sounds. They were said to be simplified to the point of requiring only one adjustment and greatly to excel the human ear in evaluating engine knocks.

Suggestions that airlines operators could effect six-figure annual savings in fuel costs by installing four- or five-figure boxes in planes, was received with something less than enthusiasm.

On the other hand, something approaching a royal welcome was accorded announcement of an instrument for evaluating detonation in the engines of land vehicles, not only with the possibility of reproducing road-ratings, but of correlating the findings with the F-1 and F-2 methods of knock testing and with such other established methods as the Borderline, Modified Uniontown, and Standard Uniontown.

Welcomed also were reports of the development of instruments for making temperature records of

pistons in operating engines. Thermoelectric thermometers installed in pistons were said to supply data which supplement test records, with both single and multi-point thermocouples – held in place by dentist's cement – used to take temperature readings of both iron and aluminum pistons in high-speed engines.

Described also was a new photoelectric dynamometer load control device making possible the maintenance of uniform loads without constant attention or attendance. The device was characterized as virtually the acme of simplicity, requiring only two photo tubes, a small lamp, and two mirrors.

Engineering progress was said to be contributing to the easier starting and better performance of engines and vehicles in the Arctic, with such ultimate results as that motorized military forces may operate in the coldest weather, and owners of civilian automotive equipment, living in northern regions, can use their cars and trucks the year round. Heater kits, "starting fluids," crankcase oil dilution, and, on occasion, special fuels, were said to assure prompt operation of both gasoline and diesel engines.

MATERIALS and Production Highlight Sessions

Based on four papers presented at two sessions on Materials, under chairmanship of **C. E. Heussner** and **E. W. Upham.** . . . "Scuff and Wear Resistant Chemical Coatings," by **F. C. Young** and **B. B. Davis,** Ford Motor Co.; "Automotive Adhesives and Sealers," by **A. J. Carter,** Chrysler Corp.; "Is There A Relation Between Metallurgy, Engineering and Materials Specifications?" by **F. G. Tatnall,** Baldwin Locomotive Works; "The Manufacture of Precision Castings," by **Gosta Vennerholm** and **E. E. Ensign,** Ford Motor Co. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in the SAE Quarterly Transactions.

JEWELRY-BOX quality and long service for tomorrow's passenger car both can be achieved by new synthetic plasticizers, chemical coatings of working parts, and new techniques of precision castings, it was disclosed at the two Materials Sessions.

The latter has opened the door to the use of new alloys, and the former results from intense war-born investigation of the nature of polymers in what one author spoke of as the close relationship of the metallurgist and design engineer in the automotive industry.

Continued coordination of engineers through SAE technical committees was urged by several speakers, and SAE standards for measurement and evaluation of chemical reagent coatings to resist scuff and wear of working parts was suggested by another.

Not only was application of sealing materials and cements described as being a boon to the automobile stylist, but improved synthetic materials and better methods of putting these materials on the vehicle without slowing down production lines were discussed. Staining and discoloring body finishes by action of cements and sealers need no longer be a problem because of discovery of stabilizers.

The stylist will find in new sealing materials and cements important aids in making the passenger car of his dream a reality. At the same time, the production engineer will find some of the new compounds helpful in reducing costs of vehicle assembly – and the motorist and truck or bus owner will benefit from years added to the life of his vehicle.

The future holds bright promise of sealing materials with numerous predetermined physical properties because of the advances in knowledge of polymers and new synthetics over a wide range of chemistry. One speaker cited the high initial and final bonding values, superior aging characteristics, with long term bonding, and high heat resistance which in turn will reduce the numbers of cements.

Test results on three processes of forming surface chemical coatings on iron and steel were reported to have increased service life several times and in several hundred diesel engines scuffing during break-in had been reduced to about one-tenth.

Age-old techniques used by earlier civilizations some 4000 years ago and forgotten, then rediscovered about 400 years ago, have been dusted of

their cobwebs. Result: the lost-wax and plaster casting promises to solve many a tough manufacturing problem, another speaker told his audience. Investment castings have achieved close tolerances on extremely hard alloys and required little or no machining when used to produce buckets for jet engines. Gears and other highly stressed working parts can be made by proper combinations of several casting methods, it was promised.

Laboratory casting is already emerging into mass production possibilities as casting techniques are being improved, and machinery is being designed to reduce time cycles now required.

Service tests and laboratory results of the effectiveness of three types of chemical coatings, formed on working parts, indicate that longer life on vehicles is in the offing. Described were caustic sulfur, iron oxide, and manganese iron phosphate treatments.

The deposits of chemical reactions form a coating which prevents scuffing and excessive wear of piston rings, cylinder liners, tappets, gear teeth, universal joint trunions, engine valves, oil pumps, and other parts.

Besides aiding lubrication, these coatings also have a tendency to prevent welding under high pressures, heat, and insufficient lubrication.

Because too little is now known about selecting the proper coating for given applications, members of the Society were urged to take an active role in developing standards of measurements and evaluation for these chemically created coatings.

Both the engineer and metallurgist should examine text results together, so that the experience of each may be called upon to improve design.

Cited, for example, were structures where some components had strengths several times those of other elements. War experience with stress gages was disclosed, and it was held that intelligent use of these devices would tell the engineer far more of strength of parts than he can possibly discover otherwise.

Tests to destruction are too often inconclusive because of the large number of factors introduced during the test program. Frequencies, amplitudes, impacts, occasional overloads, and superimposed vibrations can be determined with electric strain gages and oscillographs. Some of the test hookups were described in detail.

TRACTOR Engineers Hear Report On Torque Converters

Based on a paper presented at one session on Tractor and Farm Machinery, under chairmanship of **B. G. Van Zee** . . . "Crawler Tractor Performance with Hydraulic Torque Converter Drive," by **A. H. Deimel,** Spicer Mfg. Division, Dana Corp. . . . This paper will appear in briefed form in a forthcoming issue of the SAE Journal, and if approved by Readers Committees will be published in full in the SAE Quarterly Transactions.

ADVANTAGES of hydraulic torque converters in tractor power transmission were emphasized at the Tractor Session, where facts as well as theories about such applications were developed in considerable volume. The tractor operator, it was pointed out, has special reason to want an automatic and infinitely variable transmission because he usually has both hands and feet busy on a multitude of levers and pedals.

Converter designers argued that proper engine and vehicle design can make possible torque converter use without any appreciable penalty in fuel economy. One claimed, in fact, that the torque converter in its useful range makes up for losses in starting by holding the engine in a region of more favorable fuel economy. Optimum results in transmission application will be obtained, it was said, only if good engineering is used for the whole problem.

The hydraulic torque converter was said to meet the four major requirements for an industrial crawler tractor transmission: namely, to give maximum horsepower at draw bar at all speeds; reduce gear ratios to a minimum; keep repair costs low; and simplify tractor operation. It was pointed out, however, that in agricultural service direct drive – with its higher efficiency and lower fuel consumption – is needed in addition to the hydraulic drive because so much of the service is at constant load and speed.

Ability of the converter-equipped tractor to pull and lift at a complete standstill like a draft animal was cited as another advantage. Efficiency, it was stated, has to be measured by work done matched against hours and against fuel consumed, not by power output alone.

Supplementing discussion about specific tractor

applications, the common problems of transmission design – whether for a bicycle, tractor, bus or tank – were stressed. Experience with hydraulic torque converters on early tanks and modern buses, in fact, were shown to have been the basis for development of suitable units for tanks in World War II, including the T7 with its 400-hp aircooled engine. Bus experience directly was responsible for providing this tank with a 21-in. hydraulic torque converter connected to the engine by a friction clutch and to the output shaft by an overrunning clutch. A through shaft passed through the center of the converter, forming a direct drive from engine to output. Connection was established by a synchrolock jaw clutch, engaged automatically at a predetermined road speed by a centrifugal governor controlling the operator air cylinder by a solenoid valve. Forward and reverse were engaged by a sliding gear operated manually by a selective lever in the driver's compartment.

Modifications made in the tank design before it went into production made necessary some modifications in the transmission after field tests revealed that sufficient twist was not developed on the output shaft to overcome the vehicle's resistance to motion on a steep hill covered with more than a foot of sticky, churned-up, thick mud.

Experiences with other tank units revealed the same pattern of demonstrating the successful application of sound design experience to new projects, constant addition to experience as new problems arose, and the definite interrelationship of transmission design with design of other vehicle parts.

Increased Lab Testing Refines Design of DIESELS

Based on seven papers presented at three sessions on Diesel Engines, under chairmanship of **M. J. Berlyn, H. F. Bryan** and **T. M. Robie**. . . . "Must Diesel Engines Smoke?" by **P. H. Schweitzer,** Pennsylvania State College; "Flame Temperature Measurements – Electronic Solution of the Temperature Equations," by **P. S. Myers** and **O. A. Uyehara,** University of Wisconsin; "Analysis of Positive Supercharger Losses," by **R. J. S. Pigott,** Gulf Research and Development Co.; "The Effect of the Nitrogen and Sulfur Content of Fuels on the Rate of Wear in Diesel Engines," by **C. C. Moore** and **W. L. Kent,** Union Oil Co. of Calif; "Minute Amounts of Cylinder Wear Are Measured with a Microscope," by **C. S. Bruce** and **J. T. Duck,** National Bureau of Standards – "Navy Diesel Fuels," by **Capt. W. C. Latrobe,** Bureau of Ships, Navy Department; "Navy Diesel Engine Research," by **W. F. Joachim,** U. S. Naval Engineering Experiment Station. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in the SAE Quarterly Transactions.

WARTIME conception of the diesel engine as being, in U. S. Navy opinion, at least, the world's most efficient prime mover, scarcely is deterring engineers, or the Navy, from seeking improvements. Navy use of diesels during the war served as an extensive testing ground and lessons there learned are being applied to bring about design and construction of better diesels and the refining of better diesel fuels and lubricants.

The Diesel Engine Sessions were torn between praise for the machine and suggestions for its improvement, with Navy engineers taking the lead in calling for, among other upgrading changes, noise reduction, elimination of vibrations, higher horsepowers, lower weights.

A researcher, from U. S. Naval Engineering Experiment Station, probably wrapped objectives in one large package by suggesting:

Improvement of theoretical efficiency by using higher compression ratios; of mechanical efficiency through advanced design, better materials, lightness; of volumetric efficiency by applying practical aerodynamic principles to curtail pumping losses, insure maximum gas flow through cylinders; of cooling efficiency by applying hydrodynamic principles to keep parts at proper temperatures; and combustion efficiency through better combustion chambers, fuel pumps, and injectors.

No words were left unsaid to raise questions in the minds of engineers that the Navy is other than deadly serious about improving the diesel with the aid of manufacturers of engines, fuels, lubricants, steels. It was explained that tests already have demonstrated the possibility of operating diesels on fuels produced from coal, natural gas, and oil shale. Research programs have been developed looking to determining what components of or additives to diesel fuels will contribute to

higher performance, and what engine modifications will take advantage of superior special fuels.

Judging from the number and variety of engineering fronts reported as developing in the battle for improved diesels, that engine is likely to have no more privacy than the proverbial goldfish and much less repose. Already developed is an electro-optical pyrometer for checking the efficiency of diesel engine combustion by tracing the graph of true flame temperature directly on an oscillograph as a function of time, crank angle, or other abscissa. The diesel will get a breathing spell pending restoration of the materials supply, but once that happens the new instrument will be calibrated and the search for proper combustion in an efficiently-designed combustion chamber will be on.

Instrument Refinements

Another optical instrument, precise to two-hundred-thousandths of an inch, or better, is being used to check the amount – and causes – of wear in the cylinders of diesel and other engines. Possibility of utilizing the instrument to measure the most minute amounts of wear is said to indicate that wear is caused by abrasion, erosion, and, in greater part, by corrosion. Tests with automobile engines were reported to have disclosed that the greater cylinder wear occurs during the warm-up period and that low water-jacket temperatures are highly contributory factors.

Diesel engine wear has been traced also to the nitrogen and sulfur content of diesel fuels, but newly-developed lubricating oils are found to be capable of reducing such wear by better than 70 per cent. Measurement of wear by chemical analysis of crankcase oil for iron content was said to have confirmed the belief that low water-jacket temperatures can be factors, tests revealing that a temperature increase to 160 degrees from 100 can reduce wear to the extent nearly of four and one-half times.

Engineers are also looking into more accurate analytical methods of evaluating the efficiency of superchargers applied to diesels, objectives being determination of leakage, windage, and blow-back compression losses, as well as sleeve bearing and gear losses. Characterized as necessary also are correct calculations for blow-back compression, effect of intake loss on delivery, and for windage and leakage in capillary seals.

Smoking tendencies, long regarded as necessarily characteristic of diesel engine operation, now are said to be unnecessary, but admittedly troublesome. Tests with diesels are said to have shown that smoking can be eliminated, but only at the cost of engine efficiency.

According to test results, normal engines burning normal fuel show practically smoke-free exhausts between one-quarter and three-quarter loads. Light loads near the misfiring point cause "cold smoke." Full and overloads lead to overly rich fuel-air mixtures and dense smoke. However, with present injection equipment, prevention of overloading throughout the speed range involves loss of low-speed torque, or lugging ability. Belated injection timing, poor fuel mixing, and low fuel volatility and cetane number were said to cause smoking.

Discussion developed that diesel engine smoking may be ascribed, sometimes accurately, to many and different causes and that definite assignment of specific causes must be regarded as arbitrary. Discussion developed also that diesel nomenclature is in the controversial stage, with considerable difference of opinion expressed as to the accuracy of such definitions as "cold smoke" and "hot smoke" and the sources and causes thereof. Controversy extends even to the fine point as to whether some fuels causing smoke actually have been in combustion, with manufacturers of injection equipment especially sensitive whenever injectors, which they contend are built to satisfy the specifications of engine manufacturers, are accused of causing smoke.

Smoking was characterized as a problem of increasing importance because of the widening use of diesel engines in land vehicles and fears that legislation against smoking would affect operating efficiency. Belief was expressed that there is no panacea for the problem, even in the consumption of higher cetane fuels and in controlling loading, and it was freely admitted the problem is surrounded by technical "ifs" which must be cleared before real progress can be made.

Report Flame Heat Studies

Studies of flame temperature were characterized as pioneering work which will contribute greatly to knowledge of combustion and to progress in diesel science. It was explained that further knowledge of what happens temperaturewise during combustion will be helpful both to producers of fuels and of engines.

Progress in developing knowledge of supercharger operating losses was said to be highly important to improving engine-operating efficiencies since, at the present time, only trial and error may be relied upon to ascertain whether results are successful. It was pointed out that extensive work must be done by way of research, accurate analysis, and developing practical formulas, as well as in solving complex new aerodynamic and mechanical problems.

Discussion pointed up the fact that a great deal of improvement in diesel engine design can be achieved through coordinated research projects, and recent work of SAE committees in this field were cited to show that the Society is in an ideal position to carry on such work.

Economics Mingle with Research at Sessions on AIR TRANSPORT

Based on eight papers presented at three sessions on Air Transport, under Chairmanship of **C. E. Swanson, W. W. Davies** and **H. R. Harris.** . . . "Engine Trouble Shooting in the Air," by **John Lindberg,** Pan American Airways, Inc., and **Clifford Sackett,** Lindberg Instrument Co.; "An Ignition Analyzer for Internal Combustion Engines," by **J. V. McNulty** and **H. C. Welch,** Scintilla Magneto Division, Bendix Aviation Corp; "Review of Air Transport Developments for the Year 1946," by **O. E. Kirchner,** American Airlines, Inc.; Future Developments in Air Transportation – "Economics," **H. E. Nourse,** United Air Lines, Inc.; "Engines," by **R. C. Loomis,** Trans World Airlines; "Aircraft Structures," by **H. E. Hoben,** American Airlines, Inc.; "Recent Developments in Thrust Augmentation as Applied to Radial Engine Installations," by **W. A. Clegern,** Consolidated Vultee Aircraft Corp.; "Complete Complete Power Egg Ground Testing," by **R. W. Lahners,** Trans World Airlines . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in the SAE Quarterly Transactions.

AIR transport engineers have definitely channeled their thinking on economic factors, and the need for coordinated research and development work is more important to the industry than ever before, it was disclosed at the three Air Transport Sessions.

A comprehensive review of transport developments during 1946, for example, referred to the most important reports on innovations and projected ideas propounded during the year, most of which were based on economic considerations that have contributed to reducing operating costs. Many of the references of this and the other seven papers were to earlier work reported in SAE papers and published in the SAE Journal.

Looking from the vantage point of an airline operator another speaker pulled back the curtain and described some of the important powerplant developments, predicting gas turbine powered commercial planes during 1947, and describing new versions of engines being readied by major engine builders.

Turbine-propeller combinations, he thought, would follow soon, and new aircraft must be designed for turbo-jet powerplants, commercial use of which he sees in about three years. The 450 mph cruising speed with the latter type of powerplant would free the airplane of vibration and noise, and would provide the operators with speeds that would then be usable.

New airborne instrumentation for complete engine analysis was presented in one paper and an ignition analyzer was described in another, while a discusser explained the temperature checking device which will be integrated in the former. This type of development was suggested more than a year ago at an SAE meeting, it was pointed out, when searches were being made to reduce excessive lost time on the ground for maintenance work.

The compact and light complete engine troubleshooter would eliminate some $23,000 cost of current trial-and-error ground crew work that an average 12-hr flight costs.

To detect any malfunctioning of the engines while in flight, the instruments described can readily be operated by inexperienced personnel, and in main were based on oscillograph equipment units of which have been in long use and are held to be trustworthy.

Although the circuits controlling the cathode ray tube of the airborne engine trouble shooter are similar to those in the standard types of oscilloscopes, many of the stages for controlling various sweep frequencies have been eliminated.

The speaker pointed out that whereas the Douglas DC-3 two engine transport had 18 cylinders, 36 valves, four magnetos, and 36 sparkplugs to cause potential troubles, the new four-engine Boeing and Republic transports each have 112 cylinders, 224 engine valves, 56 magnetos, and 224 sparkplugs.

When the flight engineer detects trouble, he can warn the ground crew of the next terminal to be prepared to make one or more replacements upon landing, instead of making wholesale replacements of such things as harness and sparkplugs. Not only costly in equipment, the conventional practice costs far more in ground crew time and still more in reducing payload flight time, it was pointed out.

Although flight test experience is meager, both an airline operating engineer and an equipment authority believed that test work has clearly demonstrated the potential value of this type of instrumentation. Once reliability of the instrument is established, its contribution to safety was expected by authors and speakers to be extremely important.

A dream of airline operators has become a real-

ization, and with the change of design thinking underway the power-egg idea of engine testing will become a fact, according to another speaker who reviewed the program of another proposal to reduce grounding time lost to the operators because of current maintenance practices.

"There is no reason why all electrical and pressure connections cannot be of the plug-in type," he said in reporting developments in this method of reducing on-the-ground time.

The so-called power-egg is thrust in place in the airplane and connection bolts are tightened, completing all required connections at once, and ground testing can proceed rapidly.

Admitting that problems surrounding the power-egg have not been solved, and that some of the phases of such operation have raised resistance, the author believed that more realistic design thinking would bring about important savings in airline operations.

Ejectors, applied to radial engines increase thrust without burning additional fuel. The ejector he described was a system of suction pump, thrust augmentor, pressure ejector, muffler, and hot air pump which uses exhaust energy to pump cooling air and thus permits the elimination of cowl flaps, reducing drag form, and overcoming cooling drag now present.

AIRCRAFT Engineers Seek Solutions in New Structures, Research

Based on six papers presented at two sessions on Aircraft, under chairmanship of **A. L. Klein** and **Peter Altman**. . . . Light-Weight Sandwich Construction – "Sandwich Materials; Metal Faces Stabilized by Honeycomb Cores," by **W. W. Troxell** and **H. C. Engel**, Glenn L. Martin Co.; "Philosophy for Design in Sandwich Type Structure." by **J. F. Korsberg**, Boeing Aircraft Co.; "Experiences of an Aircraft Manufacturer with Sandwich Material," by **H. B. Gibbons**, Chance-Vought Aircraft Division, United Aircraft Corp. "Design Features of the North American Navion," by **S. C. Hellman** and **Ed Schmued**, North American Aviation, Inc. Practical Problems in Reducing Noise in Personal Airplanes – "Engine and Airframe Aspect," by **B. J. Simons**, Stinson Division Consolidated Vultee Aircraft Corp.; "Propeller Aspect," by **L. J. Trigg**, Sensenich Bros. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in the SAE Quarterly Transactions.

ENGINEERS made progress at the aircraft sessions in the search for two of their ideals – noiseless airplanes and a structural material weighing an irreducible minimum. They also attacked problems attending development of a controllable pitch propeller for light airplanes and showed interest in a description of a new, high-performance light airplane designed for maximum safety and having the load-carrying capacity of the family car. They learned of a new seal for hydraulic use.

Noise Reduction

Noise reduction of personal airplanes was described as being a tough engineering problem that must be solved if the private airplane is to achieve its greatest utility. For noise, it was reported, is a major civic objection to the strategic placement of airports in business and residential districts.

At the same time, it was said, elimination of noises within the cabin of the aircraft is equally desirable, particularly high-frequency noises, which, all agreed, are more distressing to the human ear than the low-frequency ones.

Main sources of aircraft noises are: airflow traveling over the outside surfaces of the plane, the engine, and the propeller, although it developed that incidental noises, such as vibration of loose parts, can also be extremely annoying.

In cutting down the noise level in the cabin, it has been found advisable to insulate all floor boards and other panels from the structure with a material such as fiberglass. It was said to be important to avoid all cracks and openings, for even the smallest opening can nullify the effect of the best soundproofing material. It was pointed out, too, that sound absorbing trim material is helpful in absorbing sounds that do reach the cabin.

Reduction of engine noises was reported to be mainly a matter of controlling exhaust noises – the only engine noises the aircraft manufacturer is able to control. Mufflers reduce noises, but of course add weight and may cause back-pressure troubles.

Present-day failures with mufflers in production installations was said to be due largely to the lack

of standardization of muffler space. It was emphasized that mufflers must be designed to fit the engine, and not be required to fit into whatever space the airframe manufacturers happen to leave – and each one leaves space of different dimensions.

It was pointed out, however, that reduction of exhaust noises alone is not effective. Experience was related with an experimental muffler installation so good that other, more disturbing noises were heard, making pilots dislike planes equipped with it.

Propeller aspect of the problem was said to be mainly one of reducing tip speed. It was reported that some gains were possible with slower-turning engines, reduction gearing, multiblade propellers, wider blades, and propellers of larger diameters rotating at more than proportionately lower rpm.

It was claimed that these gains were not enough. It was suggested that unconventional methods of noise reduction be studied in an effort to find ways of making more drastic reductions. A plea was made for an extensive research program backed by governmental agencies, and engine, airframe, and propeller manufacturers, that would attack the more basic aspects.

Sandwich Construction

Sandwich construction was recommended as an ideal structural material to provide maximum strength with lightness. Controversy developed, however, as to the best materials for its construction, particularly core material.

One author recommended a sandwich consisting of high strength aluminum faces and a balsa core, and known as metalite. Balsa wood was used for the core because it was claimed to have tensile and compressive strength plus stiffness superior to any plastic material yet developed, although it was admitted that a suitable plastic would be more desirable, since it wouldn't be as variable in quality as a material of nature.

Other core materials suggested were a honeycomb type, formed of a dense, impregnated fabric or paper. Some applications, it was claimed, might best be solved by a sandwich consisting of a fiberglass face material with a hard, foam rubber core, as this combination can be used where strength requirements are not severe, but excellent formability is needed.

The trend in face material was seen as toward the high-strength aluminum alloy, because of its good strength-weight characteristics.

All agreed that the toughest problem has been to find a suitable adhesive – one that would give a strong bond between face and core. The Chrysler cycleweld process was said to have led the way in solving this headache. In the case of metalite, the cycleweld cement is cured to the metal faces only, final bonding of the faces to the core being accomplished with a medium-temperature phenolic resin adhesive. Success with cycleweld was reported as due, in part, to its flexibility, which reduces the possibility of stress concentration.

Versatility of sandwich construction can be appreciated when it is realized that it is giving satisfactory performance in doors, flooring, partitions, shelves, bulkheads, and wings. It is also readily applicable to such nonaircraft uses as skis, houses, trailer bodies, railroad cars, shipping containers, and furniture.

Controllable Pitch Propellers

Controllable pitch propellers were recommended for light, two-place aircraft as giving a large takeoff and climb improvement, unless weight and cost considerations indicate that the simpler, automatic, two-position design is the best compromise.

For the larger four-place plane it was said the controllable pitch propeller was clearly best, if full advantage is to be taken of the performance of which the design is capable, and the use of either constant-speed or selective pitch designs is warranted.

Whether to go to the controllable pitch propeller was said to depend, in the final analysis, on whether the improved performance offset the increased cost and weight.

In this connection standardization of mounting flanges was called for, weight and cost penalties resulting from its lack. It was proposed that propeller manufacturers seek to reduce propeller cost at least to $1 per hp, both for the two-position automatic propeller up to 150 hp and for the constant-speed propeller up to 250 hp.

Light Plane Design

Design details of the North American Navion were revealed. It was explained that this all-metal, four-place plane, developed in 120,000 man-hr of engineering time, is safe for civilian pilots, satisfactory for professionals to fly.

Hydraulic Seal

A new synthetic rubber O-ring or doughnut seal has been devised for use at operating pressures of 3000 and even 5000 psi, replacing the older devices that were effective at pressures below 1500 psi, but fail at the pressures being reached in the newest hydraulic systems.

The seal can be made perfectly leakproof with static pistons and is satisfactory with reciprocating pistons. It can be used over a temperature range of −60 to 250 F. Life expectancy was said to be 100,000-500,000 c.

Provided the seal is precompressed between groove bottom and sealing wall at all points and clearance does not permit extrusion, it was said to be satisfactory for elliptical, round-cornered, rectangular, and noncircular shaft sections.

Evolution

WE have just passed through the worst year in American industrial history. We have never suffered more work stoppages. We have never lost more man-days of production.

Nobody has gained anything from these work stoppages and lost days of production. On the contrary, everybody has lost. Wage increases have been nullified necessarily by price rises. With production low, no manufacturer could continue to lose money and stay in business.

We learned, in 1946, that everyone in America is dependent upon someone else, clear back to the raw material stage. . . . I believe we now realize, as never before, that all of us in labor and management must get together – and start pulling together! . . . We must put aside all of our purely selfish interests and think only in terms of the general good.

I used the word "evolution" in the formal title of my paper because I don't think we are going to get up tomorrow morning and find the right answers before breakfast. It has taken us years to get into the current economic tangle. It's going to take us quite a while to get out. . . . I used the words "industrial democracy" because the theories which we have used with such great success politically can – and will – work to the general good industrially. Both labor and management must now try – as never before – to achieve good citizenship in industry. . . . In our political democracy, we sooner or later find a common middle ground. It's high time we do that in industry. Further postponement will make it only harder for labor and management to get together.

Both labor and management, I believe, will have to take several corrective steps before reaching the common middle ground, where we will find the road to a standard of living such as we have never known before.

More than anything else, we need legislation giving unions legal responsibility equal to that which management received years ago. It has been demonstrated in the past year, most conclusively, that authority without responsibility will *not* work. . . . The willing acceptance of legal responsibility by labor is one of the most important corrective steps which workers can take to reach the common middle ground. . . . It will mark the end of the selfish labor leader whose foremost thought has been to perpetuate himself in office. (I am not implying that all labor leaders, or even most of them, are in this category.)

For too many years, far too many unions have been run by militant minorities. . . . My sincere suggestion to all union members everywhere is this:

Take an active interest in your union. Participate in all its affairs. Attend union meetings regularly. Above all, cast your vote as good industrial citizens in all your union elections.

Two additional suggestions to labor before turning to the many corrective steps which management should take to reach the middle ground:

Be willing always to do a fair day's work for a fair day's pay. That's the only way mass production can succeed. Mass production makes possible mass purchasing. And it's the turnover of building and buying that keeps our standard of living the highest in the world today.

Secondly, rid yourself of the cancer of Communism. Communists are opposed to everything which has made our country great.

And now for the corrective steps which management should take:

Management should abandon – forever – its negative attitude toward questions of supreme human importance, such as job security, health and accident insurance, pensions, and paid vacations. It must acquire and constantly maintain positive attitudes toward these and other questions which mean a betterment in the position of the worker and, consequently, in the position of management.

I don't know the answer to the question of the annual wage in the automobile industry. But we are trying actively to find the answer. We are proceeding from the premise that an annual wage is possible and good. That may, or may not, turn out to be true. But at least, we have started out positively, instead of negatively, in our honest search for the truth.

Management must abandon, once and for all, the lingering belief that workers are interested only in their pay checks . . . must see that the worker finds satisfaction in his job beyond, and in addition to, his financial reward. . . . Management must encourage the worker to become *really* interested in his job and to feel he is a member of a real community.

Need for understanding is illustrated by the subjects of profits. There is no security for any worker in any company which cannot make a profit. . . . Without profits, we cannot have research and expansion and all the other factors involved in stable employment at fair wages (I am not suggesting any of these things as substitutes, in whole or in part, for adequate financial reward. If the financial reward is not fair, then none of these other things is possible.)

Applied to Industrial Democracy

EXCERPTS FROM A PAPER BY

George T. Christopher

Mr. Christopher is president of the Packard Motor Car Co. This paper, "Evolution Applied to Industrial Democracy," comprised the Production Session at the 1947 SAE Annual Meeting. Chairman at the session was N. A. Moore, SAE vice-president for Production in 1946.

Men in labor and management must realize that their ultimate goals are the same. Both seek high production—management, for efficiency; labor, for availability of the things they make. Both seek lowest possible prices—management, for an expansion of market; labor, for ease of purchase. Both seek good wages—management, to attract good workmen; labor, for an increased standard of living.

Unless we in management are utterly and completely sincere, we will never be able to develop team spirit in our plants.

We must have the best possible people working in our labor relations departments. . . . Too many such departments have existed solely to handle troubles. They have devoted too little of their time to prevention of trouble through suggestions. Their approach has too often been negative, instead of positive.

But we must not turn these problems over entirely to our labor relations departments, neglecting them ourselves. It is going to take all of us—thinking and working together—to find the right answers.

Our future welfare depends solely upon our own efforts. Our achievements are limited only by our desire to work and produce. New frontiers are all around us, if only we will open our eyes and seek them out.

We can reach higher living standards only through productivity, and our productivity depends principally upon our ability to get along and work with each other.

But we must become conditioned to the fact that all of this is going to take time—that we can achieve true industrial democracy only through evolution, *not* revolution.

Production Robots

BASED ON A PAPER BY **J. H. MANSFIELD***

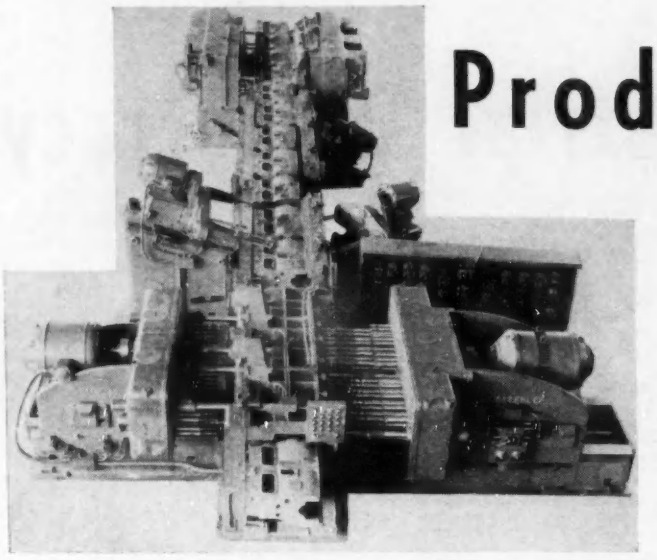


Fig. 1 – This transfer machine is one of a three-unit installation that drills holes in a diesel engine crankcase

THE transfer machine offers a new high in low-cost mass production by combining two old concepts in a single entity. Integrated in this one unit are standard straight-line production tools plus automatic work-piece handling – patterned after the water-passing technique of the old fire-fighting brigades.

In a straight production line, each of the conveyors and machines in the group performs its individual operation in proper sequence. A rough casting or forging starts at one end of the line and leaves the other end ready for assembly. But an operator must load the work at each machine, unload it after completion of the machine's operation or operations, and return it to the conveyor for the next operation in the sequence.

Machines in these lines range from simple single-spindle drill presses to complicated multi-station machines. Breakdown of any unit in the line usually shuts down the entire line since conveyors between machines have no storage space for accumulation of a large number of parts.

The transfer machine combines these individual machine tools into one unit. The operator places the work piece in at one end of the unit and it passes from work station to work station, undergoing scores of machining operations, without an operator handling the part until it emerges at the other end. The work is automatically clamped, located, and transferred to each machine unit. This is why the transfer machine gives such high productivity per man-hour. How many men are saved depends on the number of work stations and on the particular job.

Basically there are two types of transfer machines. The first is designed for automatic locating, clamping, and transferring on a particular face – such as the oil pan contact face on a cylinder block.

The second type handles work that must be fastened to a work-holding fixture with hardened ways that transfers through the machine. The fixture is then unloaded and returned to the infeed end, ready to be reloaded for the next pass. This type makes possible machining of unusual shaped pieces without a surface for transferring.

Work requiring many operations at different angles is especially well suited for transfer machine processing.

Chip disposal conveyors are a must. Their design depends on the type of material handled and on whether the machining is done bone dry or with cutting compound. Stringy and spring-like steel chips make successful handling of the part through the machine almost impossible.

Some production men question the possibility of keeping the transfer machine in continuous operation because of the many electrical and hydraulic controls. Compared with a line of single-station machines performing the same operations, the transfer machine has but a few more controls.

Electrical control cabinets on some installations now running have not been opened for servicing or inspection for more than six months. Hydraulic controls on transfer machines are just as dependable as hydraulic brakes and automatic transmissions in present day automotive vehicles.

Interlocks on the machine prevent the starting of one function – such as transfer, clamping, machining, and unclamping – before the previous one is completed. Should any trouble occur, lights immediately indicate the source.

Functions performed by transfer machines can be divided as follows:

1. Transfer to first work station and from station to station;
2. Locating and clamping in each fixture;
3. Rapid approach of tools to work;
4. Feeding tools through their cutting cycle;
5. Returning tools clear of work;
6. Unclamping and indicating the machine is clear, ready for the next piece.

Since the operator loads during the cutting portion of the cycle, no time is consumed in this operation. Useful work is done by the cutting tools

* Paper "Transfer Machines – Robots of Production," by J. H. Mansfield, Chief Engineer of Greenlee Bros. & Co., was presented at the SAE Detroit Section, Dec. 2, 1946.

Cut Machining Costs

In the light of today's cry for greater production, the transfer machine is suggested as an important aid toward lowering costs.

In this article Mansfield shows why this machine makes possible great savings in labor and time – and even in tooling costs.

He demonstrates fundamentals of transfer machine operation and outlines important considerations in transfer machine design. Unusual features of recent installations are highlighted.

during the production part of the cycle – the fourth step above. The rest is idle time.

As in any production machine, efficiency is measured by the ratio of idle time to the time the tools are cutting in each cycle. Another factor must be introduced to cover down time caused by tool changes, operator's personal time away from the machine, and miscellaneous details. It usually averages 20% of the total cycle, giving an efficiency of 80%.

This is how a transfer machine's output is computed in a typical setup:

1. Transfer	5.0 sec
2. Locate and clamp	2.0 sec
3. Rapid approach of cutting tools	0.5 sec
4. Tools cutting metal	20.0 sec
5. Return of tools clear of work	0.5 sec
6. Unclamp	2.0 sec
Total	30.0 sec

Dividing 3600 (number of seconds in an hour) by 30 sec (total cycle time) indicates a production of 120 pieces per hr at 100% efficiency. If the efficiency is 80%, total hourly production is 96 pieces.

In analyzing a transfer machine, production output is determined by adding the idle portion of a standard cycle to the longest operation completed by any one tool. Cutting speeds and feeds must be so regulated that the heaviest loaded tools run a full shift or more without changing.

Other factors also require consideration . . . hardness of material being machined . . . rough or finished surface . . . scale or no scale. Records must be kept of tools to be changed every shift or every other shift. Some lightly loaded tools will run several shifts.

Deep-hole drilling may necessitate dividing the work among a number of drills at several stations. In drilling oil gallery holes the length of the cylinder block, nine passes may be required to attain the desired production. Since center distances between holes control the size of spindles and bearings, additional stations may be required so that holes on close centers may be drilled by different units. In this way large heavy spindles can be built to run almost indefinitely – an important advantage of the transfer machine.

Inspection stations in the machine following important operations can greatly reduce scrap.

Transfer machines are tailored for a specific job.

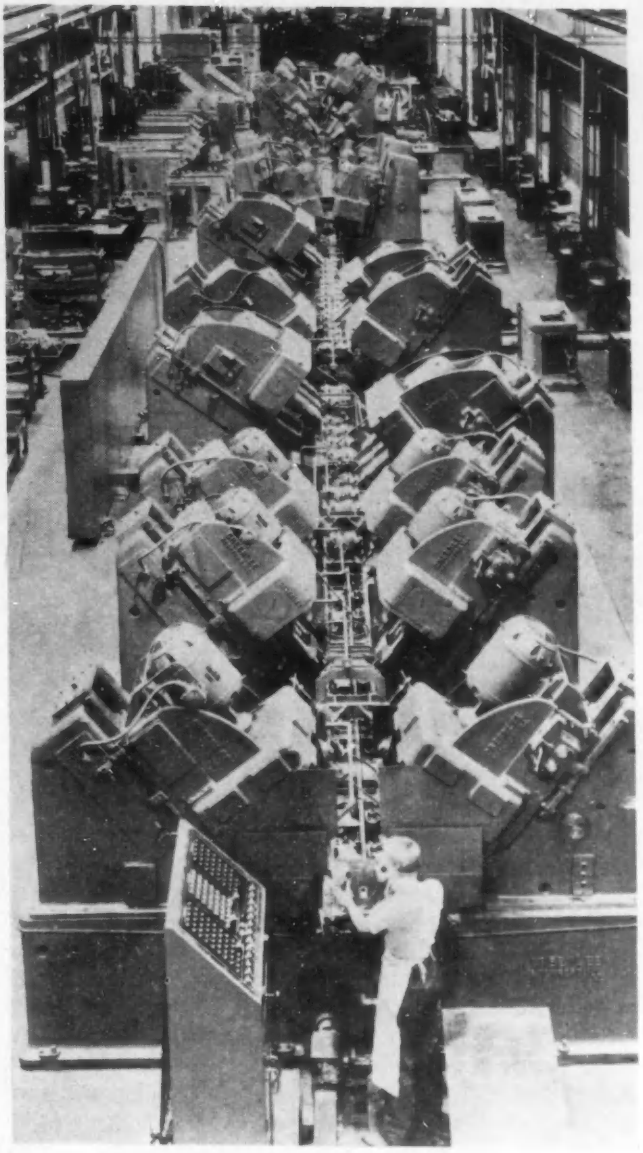


Fig. 2 – Some 284 operations are performed on each aircraft engine head passing through this 209-ft transfer machine

The installation shown in Fig. 1 is one of a group of three designed to machine diesel and semi-diesel engine crankcases. This machine drills top and bottom holes and several at an angle in the case

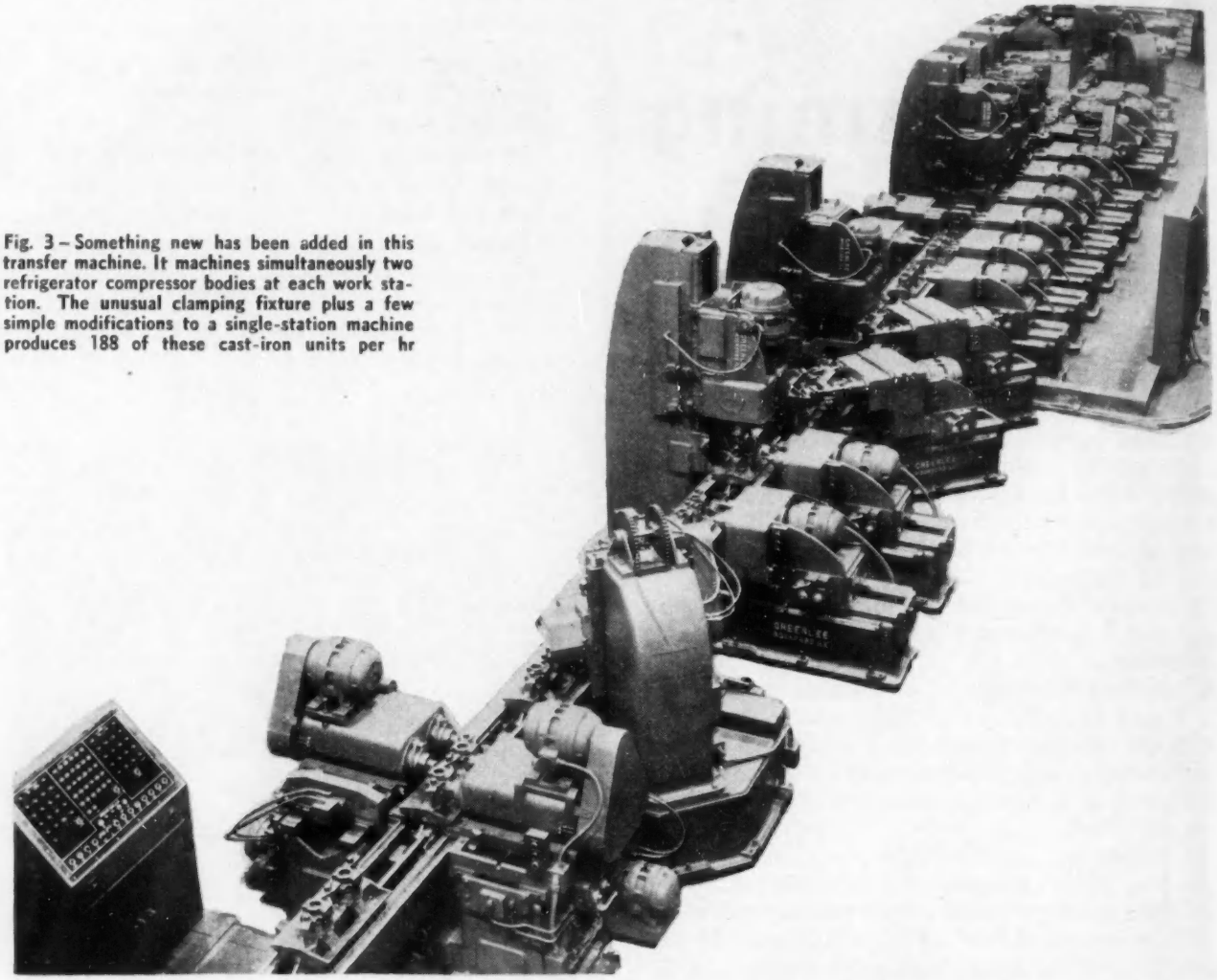


Fig. 3 – Something new has been added in this transfer machine. It machines simultaneously two refrigerator compressor bodies at each work station. The unusual clamping fixture plus a few simple modifications to a single-station machine produces 188 of these cast-iron units per hr

side; then taps them in final position. The machine has six working stations and ten idle ones. With an operator on each of the three machines, maximum production is 25 units per hour.

Each machine in the group delivers cases to an accumulating conveyor or directly to the next machine, depending on whether low or high production is required. One operator running the three machines produces about 10 blocks per hr. He runs a number of cases through the first machine and accumulates them on a conveyor in back of it; then he shuts down the first machine and passes them through the second.

Labor cost per case is the same with an operator on each machine for maximum production as with one operator running three for lower production.

Parts of the fixtures and heads are easily removable, there being one set for each of three different crankcases. Tapping units consist of three different stations with suitable heads for each.

First machine in this group performs 173 operations; the second, 114; and the third, 168.

Latest transfer machine built for fabricating aircraft cylinder heads, Fig. 2, performs 284 operations on each head. This line consists of three units, 209 ft in length. Powering these units are 82 motors totaling 353 1/3 hp; 16¼ miles of wire connect 1373 push buttons, relays, timers, and contactors.

Most recent transfer machine delivered, shown in Fig. 3, differs from the others in that two pieces of work are clamped to each transferring fixture and worked simultaneously at each station. It drills, mills, bores, counterbores, faces, and taps holes in cast-iron refrigerator compressor bodies. By working on two compressor bodies at each station, the machine attains a production of 188 pieces per hr at 80% efficiency.

Total cost of the machine is less than two lines, each working on a single casting. Each machine carries a double set of tools, requiring only the addition of a second set of spindles and double work-holding fixtures over a single-position machine. Machine frames, slides, heads, and drives are the same as those for a single-position machine.

Recent electronic developments promise still greater improvements in transfer machines. For example, varying feed rates – by controlling current input of the motor running the tool – insures a maximum tool load throughout the cycle. This device should increase total production and lengthen tool life.

● This Is Your Program

FROM A PAPER **By A. L. MORSE***

THE aeronautic industry took delivery of a program ten years ago when the Civil Aeronautics Administration established its Technical Development Service. This program involves development and test projects looking to the reduction of accidents and their attendant loss of life and property.

It is your program because we who are charged with this responsibility are guided by your suggestions as to the problems we undertake and the procedures that we follow. In so far as money and manpower permit, we attempt to satisfy the integrated development requisites of the manufacturers, the air carriers, the Army, the Navy, and Government agencies.

The Technical Development Service activities include developments in the fields of radio, airports, navigation devices and the developments discussed in this paper which involve aircraft and accessories. We avoid any developments that can be undertaken by private industry.

The current program of the Aircraft Development Division includes four test projects. Facilities for two of these are under construction. Nine developments previously initiated are inactive because of budgetary limitations. Many of these are in the final stages of completion:

Active Projects

● *Development of Fire Protection* for transport aircraft complete and operating engine installations are set up facing into an air blast simulating flight conditions. Fires are created in the engine and nacelle with a view to eliminating sources of fire ignition, developing fire resistant construction and compartmentation, developing adequate fire detecting and extinguishing systems and to determine correct procedure on the part of aircraft crews in the event of fire. Associated tests involve aircraft equipment and materials. Initiated in 1938 this work has resulted in the completion of fuel dumping tests, DC-3, CW-20, and Waco engine fire tests, and cargo compartment tests. Tests on a B-29 engine installation are now in progress. The development of fire-resistant coatings for doped fabrics is in progress. Several hundred fabric panels have been fire tested with promising results. Future planning involves tests of a Lockheed 89, a C-69 and an Allison engine installation.

● *Development of Fire Protection for Jet Propelled Aircraft.* When the proposed facilities are erected, complete and operating jet engine installations will be coupled to a blower arrangement simulating airflow through the engine in flight. Fires will be created in the engine with a view to determining existing fire hazards due to normal and military operation, properly locating fire seal bulkheads, evaluating methods of cooling with respect to their effect on fire hazards, providing means for proper drainage and ventilation, determining the effectiveness of combustible fluid shut-offs, determining requirements for fire detecting and extinguishing systems, and to determine proper crew procedure in the event of a fire in flight. Associated tests will involve equipment and materials. As of November 1, 1946, bids for buildings are due November 5. Bids for an air blower arrangement have been invited.

● *Development of Aircraft Windshield Protection.* Cockpit enclosures with windshields installed are tested to develop increased resistance to collisions with birds during flight. A compressed air cannon is used to project bird carcasses against the windshields at high velocities. Various types of de-icing arrangements are incorporated in the windshields. Improved optical characteristics are developed through photographic tests. This program was initiated in July, 1942. It has resulted, and is resulting, in the development and use of windshields having high resistance to bird impact.

● *Development of Crash-resistant Fuel Tanks.* Facilities now under construction will be used to subject fuel tanks to decelerations up to 20 g or to crash them. These include a three-hundred foot track on which a car with the tank attached is speeded up to 100 mph through use of an aircraft launching catapult. An arresting gear decelerates the car. The tanks may be secured to the car or allowed to leave the car and crash. These tests are to determine satisfactory tank materials, improved methods of tank construction and the effects of the

* Paper, "This Is Your Program," by A. L. Morse, acting chief, Aircraft Development Division, CAA, was presented at the SAE National Air Transport Engineering Meeting, Dec., 1946, Chicago.

surrounding aircraft structures on tank ruptures. The initial construction of the building and test track was started in January, 1946.

Inactive Projects

• *Instrumentation for Measuring & Analyzing Vibration & Flutter,* a project initiated in 1940, to develop an aggregation of instrumentation that would facilitate measurements and analysis of these phenomena. Numerous contracts were let for the many items of equipment. Various pickups, amplifiers, recorders, analyzers and associated calibrating instruments have been delivered. Some are now being used by CAA regulatory personnel. The rest are at the Experimental Station. Included are devices for shaking aircraft structures, pick-up calibrators, magnetic tape recorders, oscillographs, mechanical and electrical frequency analyzers, a transient wave recorder and play-back unit, an electronic oscillator, a wave form generator and a portable flight vibration recorder. It remains to test these instruments in the laboratory and in flight, and to prepare reports.

• *Photographic Flight Path Recorder & Analyzer,* involving electrically controlled cameras and an analyzing projector obtain space-time data on take-offs and landings from which distances, heights, speeds, rates of climb and descent and accelerations can be obtained. Two types were developed, a, Two widely separated cameras are parallel to the line of flight. They are electrically controlled to obtain simultaneous pictures of the airplane at the rate of four per second. Side-by-side projection permits distance between airplane images to be measured in terms of distance from cameras to airplane, and height to be measured from horizontal reference line. This equipment has a distance range of 12,000 feet, and a height range of 750 feet and b, one camera is located 1500 feet from the runway and is "pammed" to follow the airplane. Electrical timing and subsequent projection on a graduated screen provides space-time records. This has a distance range of 7,000 feet, and a height range of 300 feet. It remains to prepare reports covering these devices. Type (a) was used during the years 1941 to 1943, to obtain some 600 records of take-offs and landings. The development of type (b) was undertaken in 1941. It is now being used by CAA personnel for certificating aircraft.

• *Photographic Instrument Recorder,* consisting of electrically controlled cameras and illuminators are designed to be mounted in the cockpit behind and above the pilots. Motion pictures of the instrument panel and cockpit are obtained at the rate of two per second. Infra-red sensitive 16 mm film and infra-red incandescent lamp illuminators obtain pictures by day or by night without disturbing the pilots' darkness vision. This is for use in flight testing and can be quickly installed. It is required to improve the illumination arrangement and to flight test this equipment. It also remains to prepare a report. This development was initiated in 1943 following two previous developments of similar arrangements in which condenser discharge lamps were used for illuminators. The weight and power requirements for the illuminators, together with their power supply units was such as to indicate the need for further investigation.

• *Development of Stall Warning Indicators.* Two types have been developed for personal aircraft, each consisting of a wing pick-up unit and a horn-light unit. Each pick-up triggers at a predetermined angle of attack and while there is still time to recover. They are not designed to function in icing conditions since personal aircraft carry no de-icing equipment. One of these employs a small vane projecting from the leading edge of the wing which closes a switch when the airflow changes from downward to upward. The other includes a diaphragm-switch connected to an opening in the leading edge which makes contact when the pressure changes to a suction. Both of these are completed.

A third type designed for air carrier use detects the initial turbulence on the upper surface of the wing near the trailing edge which occurs before the airplane stalls. The pick-up comprises a small electrically de-iced, streamlined protuberance with two openings. In normal flight the airflow through the pick-up cools two hot filaments in a bridge circuit. When turbulence occurs, the airflow stops, the filaments get hotter, the bridge balance is upset and a relay is triggered. The horn warning unit includes the word, "STALL," which is lighted when the horn blows. It also includes a dimming arrangement for night use and a thermal horn cut-out, reset arrangement to avoid continual sounding that would result from no airflow when the airplane is on the ground. In flight tests, warning before the stall was obtained even with 1½ inches of simulated ice on the leading edge of the wings. A moderate amount of additional flight testing will be necessary to complete the development of this instrument.

• *Development of Aircraft Position Lights.* Improved brilliancy, distinctiveness and ability to attract attention of aircraft running lights have been obtained through the development of the flashing wing tip and two color tail lights. Several types of electric discharge lights including neon were also developed but are not considered practical for use with low voltage DC electrical systems. A high intensity auxiliary forward light with an oscillating beam was obtained and flight tested. This experimental unit was sufficiently effective to warrant the development of a similar unit suitable for installation on air carrier aircraft. This remains to be accomplished and reports must be prepared.

• *Development of Control Characteristics Recorded* to obtain flight records of control forces,

control surface positions and certain instrument indications on electrically marked paper through use of pick-ups, a power supply unit and a ten-channel recorder. Each channel comprises a laminated marking device, 1¼ inches wide, incorporating 40 contactors spaced at .03 inches and insulated from each other. Each pick-up includes a commutator device with 40 segments. As the paper is advanced, the contactors are energized in sequence so as to produce a curve on the paper. Originally intended for flight test purposes only, this device now appears promising as a flight log for regular air line operation. It appears possible to provide electrical means for actuating the commutator rotors which will impose no torque load on the instruments. Experimental components of the recorder and commutator have been made and tested. It remains to design and build a complete flight recorder, to develop clamp-on handles which will rotate the commutator when force is applied, and to develop suitable means for translating instrument pointer movements into commutator movement.

• *Development of Cockpit and Instrument Illumination.* Various types of ultra-violet-fluorescent marking systems have been flight tested. Laboratory tests have also been made of a system using retroreflective instrument marking and a single illuminator near each pilot's eye. This comprises two grain-of-wheat size incandescent lamps and a red filter. The instrument markings reflect the majority of the light back to the pilot's eye in a narrow beam of high relative intensity such that very little light is required for clear definition of the instruments. Further development, including laboratory and flight testing, is required before the practicability of this system can be determined.

• *Development of Fabric Tester,* a project undertaken in 1942 to provide inspectors in the field with a device that will replace the human thumb for inspecting fabric. The development of the instrument itself is completed. One manufacturer is tooled up to produce it. This comprises a cylindrical handle enclosing a spring-actuated hammer, a stem terminating in a circular pad which projects from the handle, and a small pin which projects down through the stem and pad. The inspector places the pad against the fabric and presses down on the handle. This compresses and releases the firing spring which causes the hammer to impinge on the pin, and the pin to impinge against the fabric. The force of the hammer blow is regulated by screwing down the rear portion of the handle. This adjustment is determined through calibration which correlates the adjustment for penetration against fabric strength. Due to the extreme variation in tensile strength from one point to another, average indications must be obtained. To determine whether the fabric has deteriorated to an unairworthy degree, the inspector adjusts the handle to a predetermined value and applies it a large number of times on the area in question. If the number of penetrations is greater than the number of tests that do not penetrate, the fabric is considered unairworthy. Additional calibration is required before this instrument can be placed in use.

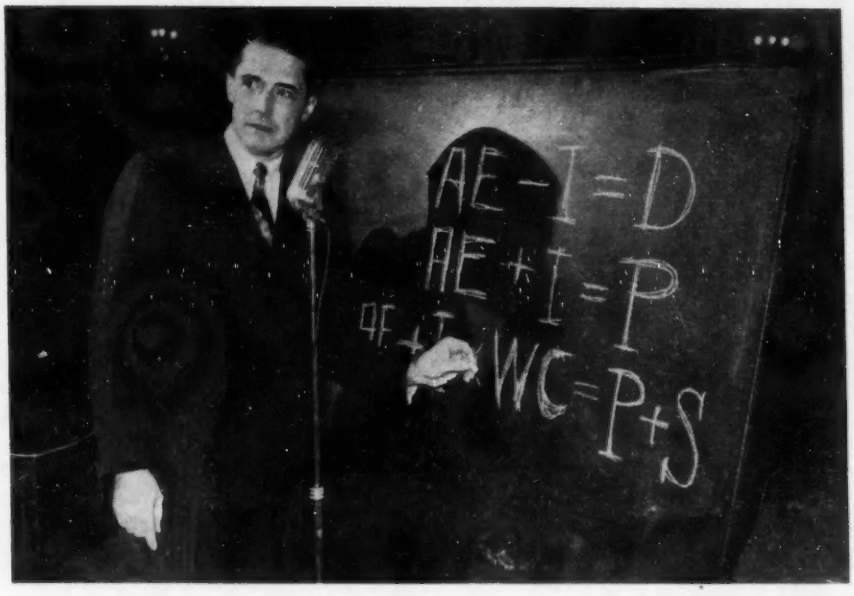
• *Development of Recording Accelerometer,* undertaken in 1941 to provide an instrument for obtaining statistical data over long periods of time of acceleration experienced in flight and landing procedures. Accelerations of durations down to 1/40 of a second are recorded through use of a multi-element pick-up and a recorder. The elements are adjusted to trigger at increasing values of acceleration. The recorder indicates the number of times each value was exceeded. One such instrumentation was completed and tested in the laboratory and in flight. This formed the basis for a second development. This comprises a pick-up about the size of a package of cigarettes and includes five leaf springs terminating in small weights. As the increasing acceleration exceeds the force of each spring, an electrical contact is broken which actuates a corresponding electric counter in the recorder. This includes dry cells for energizing the device.

Barring unforeseen delays, the jet engine fire test facilities are expected to be ready for occupancy by March, 1948. Fuel tank tests should be under way by June, 1947. Piston engine installation fire tests, tests of fabric panels and other associated fire tests, are expected to continue at an accelerated rate. Impact tests of specific windshield installations on a fee basis to show compliance with regulations and for developing improved windshields will continue.

If budget requests are granted, money and personnel will become available in July, 1947, to renew work on the more urgent phases of projects on vibration and flutter, photographic flight path recorder and analyzer, stall warning indicators, position lights, fabric tester and recording accelerometer.

The Aircraft Development Division at the CAA Experimental Station in Indianapolis will appreciate receiving your comments and suggestions. We would like to know if the projects that we plan to reactivate are still considered important. We will be pleased to entertain requests for other projects. However, developments will not be undertaken that can, and should, be undertaken by industry itself, except that developments will be undertaken if they are urgently needed by CAA regulatory personnel for discharging their duties, or to reduce recurring accidents, provided that the development costs outweigh anticipated selling profits.

You, or your representative, are invited to participate in our test programs through witnessing the tests and participating in the discussions which determine procedures. Come and see us sometime. This is your program!



Atomic

By H. B. HASS*

THE most devastating explosion in the history of the world on August 5, 1945, announced the most important scientific discovery of all time, the controlled release of atomic energy. In my opinion, it will take many thousands of years to realize fully the consequences of what happened at Hiroshima. Some are calling the new weapon barbarous and inhumane. Others say that it will usher in a new era of human progress in contrast to which all previous civilizations will seem primitive.

My views are here presented not because I feel myself to be wiser than others who are speaking and writing on the subject, but because I have been thinking about it longer than many of them. In the spring of 1942 I was called in as a consultant on the Manhattan project and on July 1st was appointed official investigator. Since then we have had at Purdue a total of 96 men and women in the Department of Chemistry working on a contract with the Manhattan District under the immediate direction of E. T. McBee.

The development of the weapon really began 49 years ago with the discovery by Becquerel, a Frenchman, that photographic plates lying in a drawer near a sample of uranium ore became fogged. Marie Curie, a Pole, and her husband Pierre, a Frenchman, then proceeded to discover radium and the phenomenon of radio-activity by which is meant the spontaneous disintegration of atoms. It was evident that enormous quantities of energy are involved in this process and the Einstein theory was, in part, an effort to explain this fact. In ordinary language, the Einstein equation states that the complete destruction of one pound of matter releases more than ten billion kilowatt hours of energy. On the principle that what you don't understand is probably of no great importance, most people ignored Einstein but mathematical physicists applied the relativity concept with great success to their problems. Einstein was a German Jew.

During World War I, Sir Ernest Rutherford, a Britisher, refused to work on anti-submarine devices because he was trying to split atoms and believed that if he succeeded the result would be more important than the war. He succeeded on a small scale. In 1932, James Chadwick, another Britisher, discovered the neutron, a unit particle of mass equal to a hydrogen atom but with no electric charge. The absence of charge enables it to penetrate the screen of electrons which surrounds the positively charged nucleus of an atom. Soon the Italian physicist, Enrico Fermi, was bombarding all sorts of atoms, including uranium, with neutrons. By 1934, Madame Curie's daughter, Irene, and her son-in-law, Jean Frederick Joliot-Curie, had discovered artificial radioactivity by which such common materials as salt and aluminum can be made to behave like radium. Still later Dr. Ernest Lawrence, an American, invented the cyclotron by which atoms can be broken by being bombarded with extremely rapidly-moving particles.

In all of the above processes of artificially de-

* Paper, "The Significance of Atomic Energy," by H. B. Hass, Department of Chemistry, Purdue University, was presented at the SAE National Fuels & Lubricants Meeting, Nov. 7, 1946, Tulsa.

Energy + Intelligence x World Cooperation = Prosperity + Security

composing atoms the quantity of energy obtained from the fissions was less than that which had to be used to bring them about. It remained for Hahn and Strassman, in Berlin, to bombard uranium with slow-moving neutrons and obtain a new effect. Dr. Lise Meitner, an Austrian physicist, and Dr. O. R. Frisch correctly interpreted this effect to be the fission of uranium.

This brings us to the subject of isotopes, which are different kinds of atoms of the same element having different weights. Most uranium atoms weigh 238 on the atomic weight scale. About one in 140 weighs 235 and one in 17,000 weighs 234. Ever since 1939 it has been evident to chemists and physicists that all that is needed to obtain atomic energy is to separate U-235 from the other two isotopes. The results were checked by several experimenters both in Europe and the United States and the grim race was on. Whatever nation was first able to separate U-235 could rule the world if it wanted to do so.

The first separation of isotopes on a microscopic scale was accomplished about 25 years ago by Aston in England. The process consists in making the atoms one by one go around a curve at high speed in a high vacuum. Just as a heavy guard on a football team can't turn and dodge as quickly as a light half-back, the heavy atoms don't change direction as readily as the lighter. One of the processes for separating U-235 from the other isotopes is based on an enlargement of this mass spectrograph.

The first separation of isotopes in quantity was performed by Prof. H. C. Urey, of Columbia University, who received a Nobel prize for making heavy water. This involved separating H^1 from H^2. Urey and his group quickly were drawn into the problem of isolating U-235 and worked on a diffusion process which took advantage of the fact that a light isotope will move faster than a heavy one and, therefore, has a greater chance of finding a hole in a filter and working its way through. By repeating this process, the desirable isotope can be separated. Another approach to the problem of release of atomic energy consists in producing from uranium 238 new chemical elements, such as neptunium which spontaneously changes into plutonium.

At the University of Chicago a complicated device was built for producing plutonium from U-238 and then separating the two. This separation is relatively easy because they are two different chemical elements rather than isotopes of a single one.

As all three of these processes—(1) shooting uranium atoms around a curve, (2) separating uranium atoms by diffusion through a filter, and (3) making plutonium—showed promise, large plants were constructed to put them into operation. The plutonium plant was at Hanford, Washington, the other two at Oak Ridge, Tennessee. There was no time for the usual less expensive method of building pilot plants since each day cut off of the war would save about 200 million dollars. Some of the plants were obsolete before they were finished because of the rapidity with which new knowledge was gained. A total of 125,000 men were used and $2,000,000 were spent on the project, but it paid for itself many times over even without considering the lives saved.

The rapid ending of the war caused by the explosions at Hiroshima and Nagasaki is familiar to us all. Many important questions are still being discussed, among them: Was the bombing morally justified? By the use of this new weapon it is estimated by Churchill that 250,000 British lives and 1,000,000 American lives were saved. But the records of the Pacific war show that Japanese casualties exceeded ours by a very large ratio; it therefore may be reasonable to assume that some-

concluded on page 52

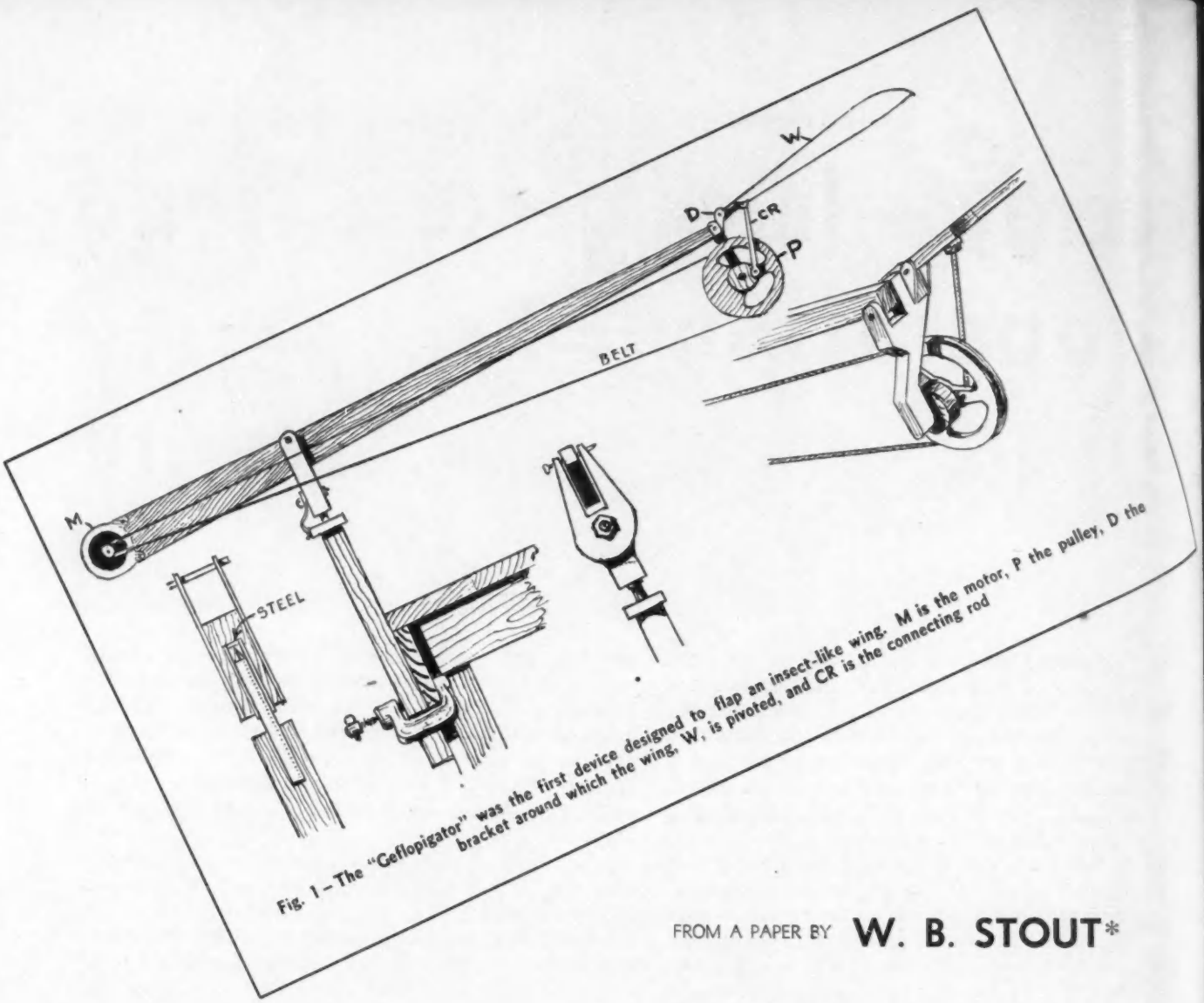


Fig. 1 – The "Geflopigator" was the first device designed to flap an insect-like wing. M is the motor, P the pulley, D the bracket around which the wing, W, is pivoted, and CR is the connecting rod

FROM A PAPER BY **W. B. STOUT***

FLAPPING-WING studies are not a new approach to flight theory but rather the rejuvenation of a fresh interest in the oldest method of all. Fossils prove the common insect's technique was established more than 50 million years ago.

Insects fly with even greater payload per unit wing area and at faster speeds than do birds, and their mechanism of flight is much simpler too. But man evades nature's methods and does it the hard way.

Wheel Inefficient in Air

The wheel is an ideal invention for the ground; but it has no place in the air. Propellers are being put on airplanes simply because it was the only way the Wright brothers knew how to fly – and no one has bothered to change since. Nature provides just the body and wings; we clutter up the airplane with a lot of bumps such as nacelles and nose spinners that are both payload and speed parasites.

In another case – the helicopter – we tried to use the wheel for direct lift. By adding tricky mechanisms, we even got bad forward flight. When the helicopter flies forward, the blade on one side goes against the air at 400 mph and the blade on the other side of the same rotation has only a 200-mph attack speed.

The result is too much lift on the approaching side and too little on the receding side. Even by adjusting the angles of attack, the blade on one side climbs and the other drops, flapping while rotating.

But suppose we construct a flying machine with two blades on opposite sides – instead of the rotating wing – and moved each one in a half circle. They would sweep the same area covered by the rotating wing. By this arrangement insects obtain both lift and thrust.

The structural problem of reversing the blade several hundred times a minute is not as bad as it seems. Blades from opposite sides coming together at the end of the stroke to complete a half circle build up air pressure between them. Inertia on the end of the stroke is dissipated on impact. This is the clapping sound heard when birds take

* Paper "A New Approach to the Flight Problem," by W. B. Stout, Consulting Engineer, was presented at the SAE National Aeronautic Meeting, Oct. 4, 1946.

NEW APPROACH to FLIGHT

off suddenly in a steep climb and the wings hit each other at the top and bottom of each stroke.

Flight secret of insects such as the "ant lion," disclosed by close observations, is a unique combination of motions. When a wing merely flaps up and down from a central supporting hinge, sufficient thrust for forward flight is obtained at the wing tips from the flexibility of the wing. But a large area remains unproductive in thrust.

Since the wing is nothing but a fan, its unusual operation is analogous to the waving of a fan. In fanning yourself, you move the fan up and down and twist the handle and your wrist at the same time. The insect's wing does the same thing, giving two distinct radii of flapping; one from the root to the tip and another simultaneously from front spar to trailing edge. When this double-motion goes to work, the entire wing is active and the entire wing thrusts.

2-Directional Flapping Improves Lift

If we could now make the house fly-type wing – that only gives thrust around the tip in horizontal flight and flapping – flap in two directions, the entire wing area would be converted to a lifting surface. This offers an imposing lift increase with the same surface when we want it all for power lift without horizontal speed.

Many insects do have wings pivoted so that the trailing edge moves around the leading edge as a pivot while the wings flap up and down. Through large arcs of operation, the wing actually becomes a helicopter – two full connected half circles of thrust. After the insect is off the ground and in flight, amplitude decreases, wing tips do more of the thrust work, the wing develops more lift from forward speed. The result is a machine very efficient in horizontal speed, impossible with a helicopter.

Advantage of the flapping wing is the helicopter take-off plus better-than-conventional-airplane forward speeds. Full engine power and flywheel effort can be used for hoverings, landings, and vertical descent. The principle is there – all that remains to be done is the engineering.

Possibilities of man-made machines flying like insects were demonstrated in a series of crude experiments. The house fly – simplest insect in both wing structure and flight technique – served as the first model.

Microscopic studies showed that all insect wings have a stiff leading edge spar, becoming more flexible from root to tip. Behind it is a flexible membrane. The first wing built was just a curved leading edge spar, tapering from the hinge out to the tip. A sheet of tissue paper was glued to the spar in tension so that springing of the spar kept it tight.

Flapping the Wing

Next came the problem of how to make the wing flap. To have it stand still and flap would make it a fan, giving no indication of lift. Using scrap parts and a little "gray matter," the problem of flapping the wing and observing its thrust was solved, as shown in Fig. 1.

An old music stand served as the base of the apparatus. The top bar was extended and the end sharpened to a point. A tube with a piece of glass at the bottom dropped over the rod gave a pin-point pivot bearing. To this was fastened a 5-ft arm. A small electric motor of about 10 "mouse-power" was installed at one end, connected to a wooden pulley at the other end by a string belt. The motor turned the wheel, on which were mounted a crank and connecting rod, on about an 8:1 reduction.

Suitable electric connections were made through commutators to carry the electricity into the motor. When the apparatus ran, the rotating pulley flexed the wing up and down through a predetermined arc at from 200 to 400 strokes per min.

Surprisingly enough, this whirling arm actually took to life under the thrust of the primitive wing. It circled around its pivot at some 20 mph.

The "Geflopigator" did give qualitative results despite its crude construction. Everything was hand-made – the pulleys cut out by saw and grooved with a V file, the bearings were wood, and the pivots were nails.

Results were so good they inspired the building of an improved apparatus, shown in Fig. 2. This time a vacuum cleaner unit was chosen as a power-plant. The arm was the same as the first except

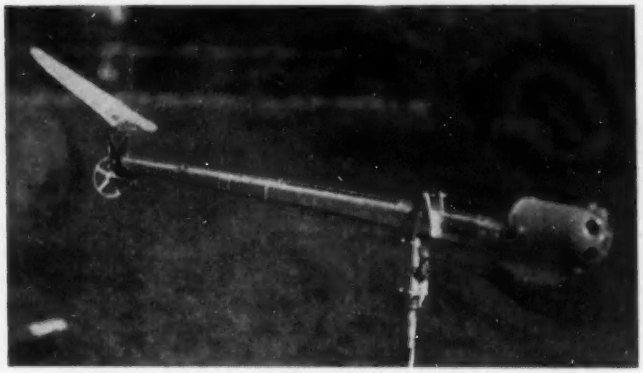


Fig. 2 – An improvement over the "Geflopigator" in Fig. 1 was the "Geflopigus". It has a shaft drive instead of a belt drive and a larger motor than the first device

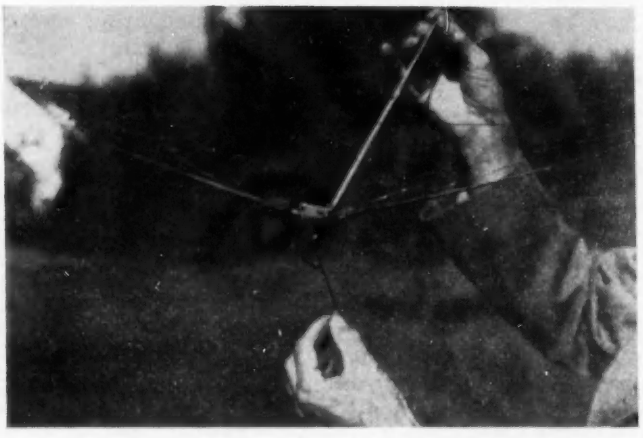


Fig. 3 – This twin-wing flying model is being used for flapping-wing experiments

that here a shaft-drive ran along the top of the spar out to the long end of the beam. At this point was a gear reduction from a pinion on the end of this high speed shaft to a large-sized gear. A connecting rod ran up from a crank on the gear to the pivoted wing.

This device is intensely interesting as different wings can be fitted to it.

No definite conclusions can be drawn from these experiments, but they do demonstrate the possibilities of wing-flapping flight.

Flight & Stress Studies To Be Made

Experiments have progressed even beyond this stage. Flying models like the one in Fig. 3 have been operated. Other experiments are now under way to test the various wing components and the method of attachment. In about another year enough definite information should be available to build a double-flapping apparatus of sufficient power to permit preliminary flight studies and some real stress analysis.

Maybe some day we will find that Icarus and his wings of wax was a lot closer to natural flight than we are with our roaring propellers.

ATOMIC ENERGY

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thing like 10,000,000 Japanese lives were saved. Can we outlaw its use in war? Military history shows no example of the successful outlawry of any really effective weapon. War is a grim business of killing or being killed and that being the case, you can scarcely expect a nation to fail to use a weapon which gives it an advantage.

Can we keep the secret? Yes, for a few years, but not in the long run. In the near future any nation which wants to spend the necessary research effort can have atomic bombs.

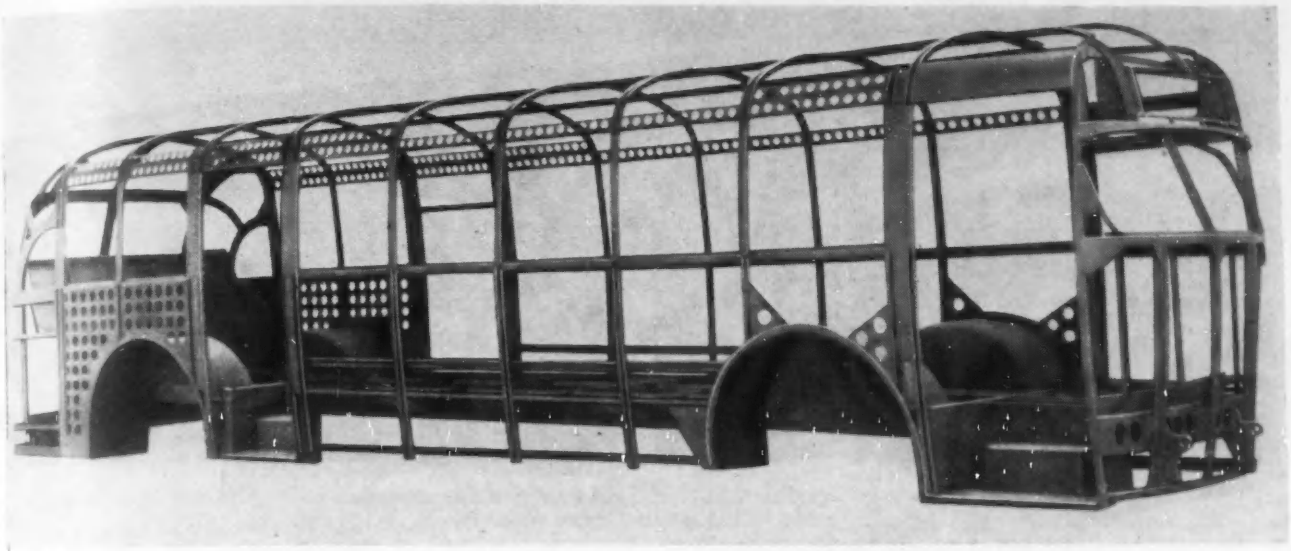
Will it be harnessed for constructive peace-time use? The whole history of science shows that every new form of energy has been successfully harnessed. It is only a matter of time.

What will it mean for the human race? That is for mankind to decide. If we wish, we may have a new era of civilization which will set us on the road leading to the abolition of poverty and infectious diseases. Or we may have wars which will make World War II look like a Sunday School picnic.

Never before was more effectively illustrated the fact that science is power; power to do good or evil. Increasing the power of mankind is one-half of human progress; the other half consists in the art of learning to what purposes we should use the increased power and persuading people to want to use it for good. The physical scientist, the social scientist, and the clergy together should face the problems of atomic power as the greatest opportunity ever offered a civilization. There is no use in deploring the inexorable march of scientific progress; the future belongs to the nations which most eagerly accept and exploit it.

An important lesson to be learned from this development is that in science the brotherhood of man already is functioning. Let no one say that we can't cooperate for our mutual benefit. We have been doing it for decades.

The other important lesson, it seems to me, is the significance of research with no immediate practical end in view. If Becquerel or Einstein or Meitner had been asked what he or she intended to accomplish by his researches, no good answer could have been given. The universe is too vast and complicated to see very far ahead in scientific research. Let us have confidence in the skilled researcher who has a highly developed instinct for what ultimately may prove to be important. Very often he is wrong but his research director is wrong still more often and a non-scientist will be wrong almost all of the time if he tries to select research problems for the scientist. Give the scientists a chance and they gradually will solve almost any problem in which they are interested.



Current MOTOR BUS Development

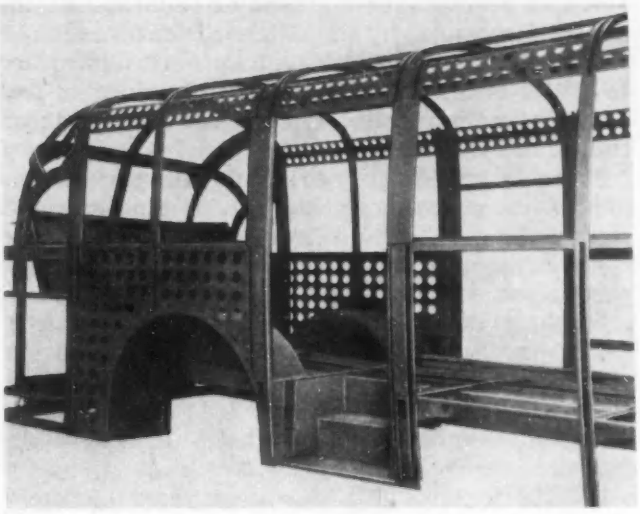


Fig. 1 (top) – Continuous curvature of externals provides maximum body stiffness as well as eye appeal; Fig. 2 (above) – Functional frame structure affords strength and lightness

BASED ON A PAPER BY **M. C. Horine***

EXPECTED longevity of a bus demands a conservative approach to styling, careful selection of components, and utmost ruggedness in structure to avoid early obsolescence and to keep operating and maintenance costs to a minimum over the years of the vehicle's life.

Successful city bus operators will consider these basic points seriously:

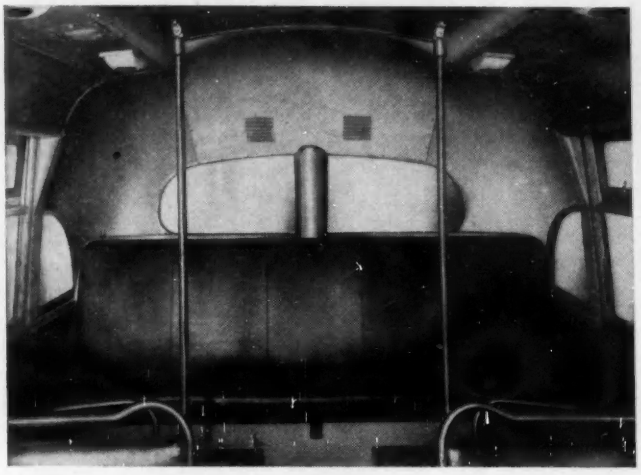
Styling – including the use of plastics – engine location, powerplant performance, adequate carburetor air intake, smooth and efficient torque conversion, adequate but light brake assemblies, riding ease, tire size in consideration of synthetic rubbers, structural ruggedness, heating and ventilating, electrical equipment, accessibility of components for ease of maintenance, and light weight of the vehicle.

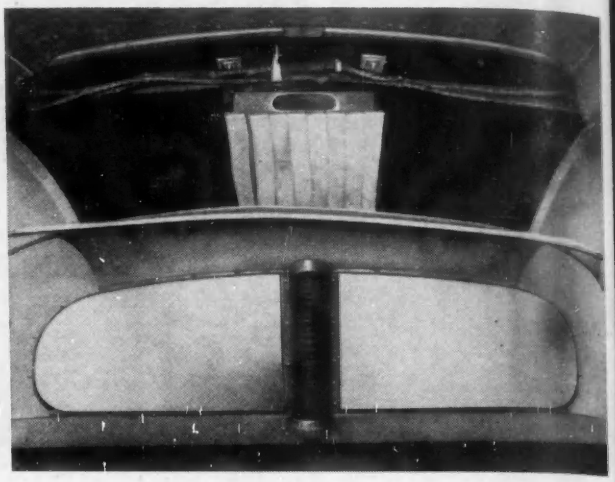
Good styling and good structure of the modern bus have gone hand in hand. Meaningless and garish embellishments – reminiscent of the circus wagon – have been indulged in from time to time by some manufacturers, but this superficial gaudiness has hidden sound structural lines.

Given the boundary dimensions, the right combination of engineering gumption and artistic idealism can produce a compromise which possesses more fundamental artistic merit than any dreamchild of the engineering illiterate. And the result is functional.

Good styling provides rounded corners for windows, windshields, and door embrasures. This is also good structure. Curved surfaces diaphragm and vibrate far less than flat surfaces, and curved

*Paper, "Current Motor Bus Development," by M. C. Horine, Mack Trucks, Inc., was presented at SAE Pittsburgh Section, March 18, 1946.





Figs. 3 and 4 – Carburetor air intake above rear seat, showing panels removed to disclose silencing box and air tube

surfaces reflect light uniformly in contrast to the aberration caused by the ripple of flat areas.

A radiused insweep of the body skirt adds grace to appearance, and also stiffens the skirt, is less prone to collect icicles, and reduces mudsplash on the side of the bus body.

It would be foolhardy to dismiss the possibilities in plastic and thermosetting wood laminations, but we must not allow ourselves to be swept off our feet by rosy prognostications. Economy in plastic parts comes by the use of large quantities of identical parts, due to the high cost of dies. Much is yet to be learned through experience about the validity of claims for these materials as structural parts, although their value for embellishment where little stress is encountered is widely accepted.

Engine locations, of which a few years ago there were five, appear to have dwindled to two. Longitudinal and vertical in front are two positions which virtually disappeared before the war. These positions encroached excessively into passenger space, made powerplants difficult to service. The saddle-bag arrangement, a dual-engine layout with powerplants located vertically under the seats on each side, amidships of the bus, was next to go in city buses, leaving the now conventional transverse rear engine and the underfloor locations. The saddle-bag arrangement is reappearing in postwar offerings, engines being mounted horizontally instead of vertically.

The rear engine mounting sequesters heat, sound, vibrations, and fumes behind the passengers. It easily effects one-third, two-thirds weight distribution, permitting equal loading of uniformly-sized tires. It provides the most compact grouping of the powerplant and its accessories, and is convenient to service without pits or lifts.

Remote control is mandatory in the rear-engine installations: in one example the hand brake rod is the only manual control. Drivers are deprived of auditory guidance for operation, and the engine and powerplant are prone to collect more dust and dirt than in other locations.

Although one-third, two-thirds load distribution is impossible in the underfloor installation unless the rear axle is located at an objectionably great distance from the rear bumper, it lowers the center of gravity of the vehicle and permits shorter and simpler controls. Nearly-orthodox transmissions and rear axles can be used, and radiator air can be taken from in front. But pits or lifts are required for servicing.

Powerplant development has been considerable in recent years, with improved power and economy, as well as smoothness, reliability, and durability. The field remains open for both otto and diesel cycles, and there is always the persistent possibility of improvements in the steam system which may not yet reach practical fruition.

What the future may hold in unconventional engine arrangements is not clear. V-type, barrel-type, opposed-piston, cone, and even radial engines are possibilities, but not soon. Gas turbine engines in buses are not likely during this decade.

Carburetor air taken from inside the passenger car compartment of a bus is the most effective of the many methods tried to date. This air is cleaner and is more nearly at a constant temperature than outdoor air. This is a definite advantage.

Torque conversion is the liveliest topic in bus engineering. Traffic, platform labor, and maintenance have discouraged the manually-operated conventional clutch. Future buses must relieve the driver of the physical effort of clutch operation and gear shifting. The tremendous amount of development of various forms of torque converters indicates that this goal may be achieved either mechanically, electrically, or hydraulically – or by combinations of two or three.

One result of the approach by mechanical means is the development of a fully-synchronized mechanical transmission and clutch, in which all operations of the clutch, gearshift, and even the throttle

Fig. 5 – Concealed air ducts through which fresh air is forced by blowers

during shifts is effected by power and in invariable sequence and timing. Thus all the advantages of the non-mechanical drives are realized with none of their limitations.

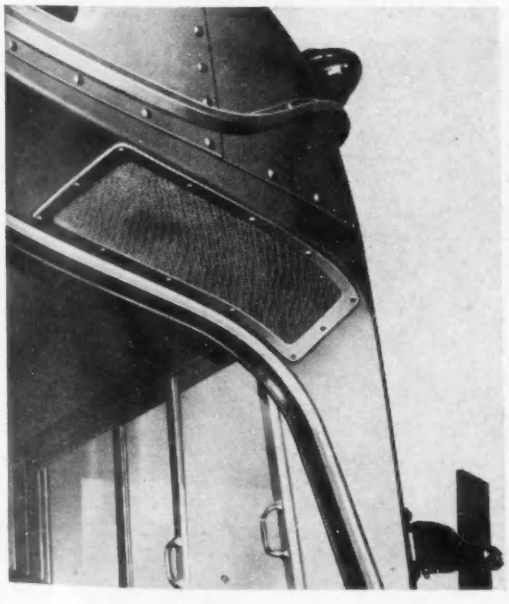
In this system, air is used as the medium both of actuation and operation of the controls – the same air which powers the brakes. There is no clutch pedal. Starting is as smooth as that of the gas-electric. The bus is set in motion, after preselecting low, by simply pressing on the accelerator and all shifts may be made with the accelerator down against the floor without clutch slipping or engine racing.

There is a manual control, but it is effortless. It comprises a fingertip lever below the steering wheel, whose manipulation requires neither skill nor judgment. Gear clashing is impossible, and a new multiple disc type synchronizer is used for each forward shift which has from nine to twelve times the life of the best cone type synchronizer known.

There are many other systems of drive in development or in contemplation. Perhaps some will not survive. But for the present bus driving, so far as ratio changing is concerned, is easier and smoother than yet attained in a passenger car.

Brakes continue to be a major problem in bus maintenance. To the credit of the bus operating fraternity, brakes are less of a safety hazard in buses than any other class of motor vehicles.

Fig. 6 – Fresh air intake, one of two, over windshield



Serious work is being done looking toward replacement of much of the pneumatic equipment of buses – in the controls, doors, wipers – yes, and brakes. If successful, we shall have lighter and simpler systems, with perhaps greater dependability and decreased maintenance.

Riding ease is the subject of a great deal more attention than ever before. This is, of course, a question of spring deflection regardless of the type of springing system employed. This applies to both spring rate and to initial deflection: There is no substitute for deflection.

It appears to be possible to get the best ride with the simple and reliable semi-elliptic spring. Elimination of all friction joints by use of rubber shock insulation and adequate hydraulic shock absorbers all around combine the acme of riding ease with the greatest reliability and lowest maintenance cost.

Tire sizes are reversing the prewar trend of becoming smaller, and the 11.00-22 tire seems to be well worth the additional poundage involved since we are obliged to run on synthetic rubber.

Smaller diameter tires had the advantage of lowering the bus floor, of using the spring deflection, and of lighter weight, but they did hug brake drums far too closely, resulting in excessive tire bead temperatures.

Structural trends, beginning before the war, continue toward functionalism, with multipurpose members, stress distribution, and unification of structure. Taking a leaf out of aircraft design practice, bus structures of today are unified, there being no separate chassis and body framing as

Fig. 7 – Axial-flow blower and dampers controlling air flow

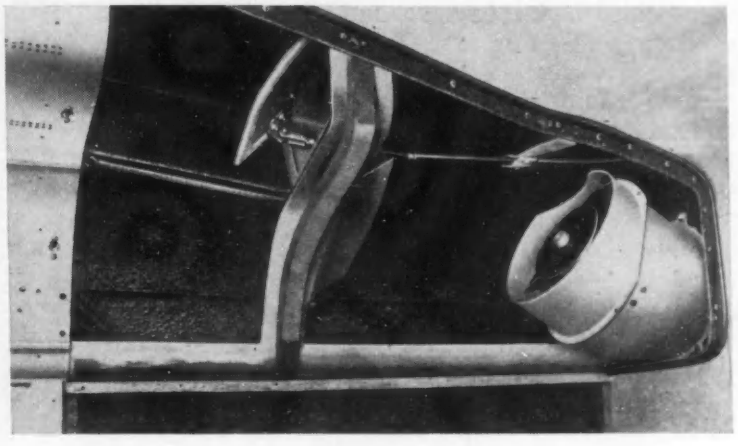


TABLE 1

WEIGHT BREAKDOWN OF A 41-PASSENGER BUS WEIGHING 18,350 LBS. WET

	Percent of Total
Rear Axle Assembly	16.9
Powerplant –	
Engine and Trans.	16.4
Body Framing and Panels	16.0
Front Axle	10.5
Chassis Framing	5.9
Seats	5.5
Fuel (100 Gallons) Water and Oil	5.5
Heating and Ventilating	2.7
Side Window Sash and Glass	2.7
Floor and Floor Covering	2.3
Doors and Control	2.2
Cooling System –	
Radiator, Shutter, Hoses	.9
Misc. as paint, insulation, nuts, bolts, rivets, etc.	12.5
TOTAL	100.0%

TABLES 2 AND 3

FUEL CONSUMPTION

1 – A 2.75% reduction in bus weight is required for a 1% improvement in fuel consumption.

2 – A reduction in bus weight of 1050 lb would be necessary to obtain a 2% improvement in fuel consumption.

3 – A difference in schedule from 10 to 6 stops per mile results in a 24% improvement in fuel consumption.

4 – Rate of deceleration has considerable effect on fuel consumption. For example, if an operator who, in an effort to improve his scheduled speed, is decelerating at the rate of 7 MPH/SEC., would reduce the rate to the normal decelerating rate of 3.5 MPH/SEC., he could improve his fuel consumption by 8.2%.

PERFORMANCE

1 – A 10.5% reduction in bus weight required for a 1% improvement in performance (schedule speed).

2 – A reduction in bus weight of 1940 lb would be necessary to obtain a 1% improvement in schedule speed.

3 – A difference in schedule from 10 to 6 stops per mile results in a 31% improvement in schedule speed.

4 – Increasing the rate of deceleration from 3.5 MPH/SEC. (normal) to 7 MPH/SEC. would result in a 5.5% improvement in schedule speed. This, naturally, would be made at a sacrifice in fuel consumption as noted in item #4 under fuel consumption.

heretofore. Each structural member serves as many different purposes as possible.

The technique of non-stressed assembly is being used today. The structure is assembled in welding bucks which hold each part in its true alignment without stress. These sections are then brought together into a unified whole, as shown in Figs. 1 and 2.

Heating and *ventilating* are among the most spectacular current bus design developments. Strictly speaking, air conditioning means not only cooling in hot weather, but also heating, ventilating, humidification, dehumidification, and filtering out dust and dirt.

Air ducts can be concealed and incorporated within the structure itself, thus serving as stiffening elements in addition to their primary function, as can be seen in Figs. 3, 4, and 7. Underfloor ducts also perform these dual functions (Fig. 8).

In one system, only three water hoses are used in the entire bus. Heating control is by air dampers, with the same volume of air circulating through the vehicle under all conditions of temperature. All of the air passes through the heating core from which it is conducted to underfloor ducts extending the full length of the body. Hollow pedestals under the seats distribute the air uniformly around the passengers' feet and legs with additional openings for the two step wells. An entirely separate passage leads forward to the driver's station.

Electrical systems have had the benefit of intensive study. Increased demands upon the bus electrical system have called for 120 amp output generators. A new system substitutes a three-phase alternator for the d-c generator, regulated by a simpler, lighter and more condensed control box. Throughout most of the speed range the output is flat.

There will certainly be a move toward fluorescent lighting of buses, requiring an a-c source.

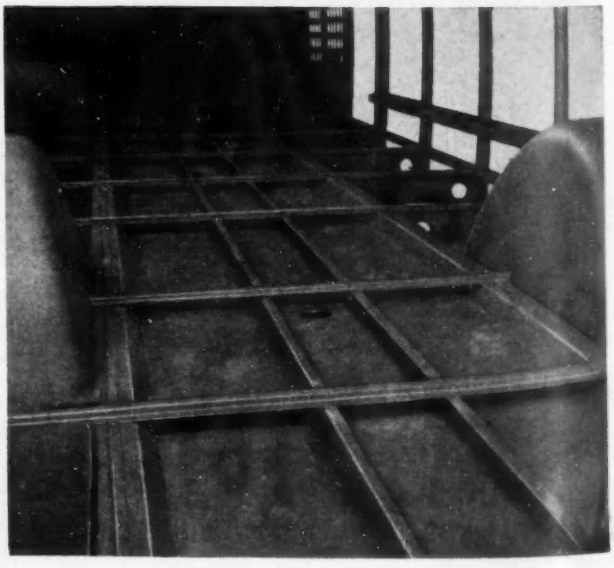
Accessibility for maintenance continues to be an important economic factor in bus operation. Durability, reliability, and accessibility are the three important influences on maintenance economy. Most spectacular of these in the new postwar offerings appears to be greater accessibility of components which must be checked and serviced.

Long overdue has been improved accessibility of instruments. One offering is a combined mechanic's and driver's panel, in the form of a dead front hinged door which swings down exposing all connections, fuses, and switches to direct access.

Weight reduction must not become short weight by sacrificing passenger comfort and convenience,

concluded on page 62

Fig. 8 – Underfloor ducts, forming a structural part of floor, by which heated air is distributed to outlets



DYNAMOMETER DIAGNOSIS Points to Cure for Vehicle Ills

FROM A PAPER **By F. C. PATTON***

DYNAMOMETER testing assures the fleet operator a successful preventive maintenance program, says Patton. By detecting mechanical deficiencies before they result in breakdowns and increased fuel and oil consumption, the dynamometer more than pays its way. He shows that:

Installation of a chassis dynamometer proved highly effective in his shop when his company was faced with inexperienced labor, careless work, reclaimed parts, and high labor turnover.

Engaged in urban passenger service with eight to ten passenger stops per mile, Patton's company controlled headway by establishing time points about 5 min apart. Maximum allowable variation at these points was one-half minute. Maintaining such a tight schedule required maximum vehicle performance at all times.

Prior to the dynamometer tests, driver control was a major problem, as a man running late usually claimed lack of power. Since the dynamometer has been installed, the vehicle can be checked and this excuse crops up very infrequently.

Expensive road calls have dropped materially and fuel and oil mileage has increased as well as the on-time performance of buses.

Major inspection in the shop is combined with the dynamometer test at 2000 to 4000-mile intervals (about once a month). It will be noted from the procedure below that the dynamometer test is the final check on all other tune-up operations.

*Paper "The Dynamometer as an Aid in Fleet Maintenance," by F. C. Patton, Manager, Los Angeles Motor Coach Lines, was presented at the SAE National Transportation & Maintenance Meeting, Oct. 16, 1946.

Chassis Dynamometer Test Procedure

1. Check battery, generator, and regulators for correct voltage and output.
2. Check starter and all lighting circuits.
3. Check both high and low tension ignition circuits. (This is important as defects in these circuits will materially affect dynamometer readings.)
4. Remove, clean, set, and replace all spark plugs.
5. Clean and set distributor points.
6. Check fuel pump and carburetor.
7. Check engine governor.
8. Anchor down vehicle on test stand and run in high gear at road speed of 18 mph. When the temperature reaches 170F, open the radiator shutters. If the horsepower reading at the rear wheels of the 210-hp type engine is between 50 and 60 and no fluctuation of the dial needles is apparent, no further test at this speed is necessary. If poor adjustment is indicated, install a vacuum gage and test for sticking or leaky valves.

   Install compression gage and check compression pressures. Break down of the ignition harness is very noticeable at this speed; if the harness is found defective replace it with a new one. The crew has been furnished with fuel and oil mileage averages. If mileage is below predetermined average, attach an exhaust gas analyzer and make carburetor adjustment before the next run is made.
9. Increase road speed to 25 mph at full throttle; 72 to 80 hp is satisfactory. If desired horsepower is not developed, repeat all previous tests and check the cam angle with a tunemeter or angle gage.
10. Increase road speed to 35 mph at full throttle for maximum horsepower test; between 86 and 100 hp (depending upon differential ratio) is considered satisfactory. Fluttering dial needles indicate trouble; if found, repeat all previous tests.
11. Make final check for engine noises, oil leaks in engine, transmission, and differential.
12. If vehicle is equipped with a double governor, run it without load in first gear and set the governor for a maximum of 8 mph.
13. Make final safety inspection of brakes, running gear, and steering before removing the vehicle from the test stand.

Air Conditioning

EXCERPTED FROM A PAPER BY

H. J. Wood*

A PLUMBER'S-EYE view of the practical problems of military aircraft air conditioning will be presented, with the hope that it will serve to establish better liaison between airplane designers and equipment engineers (as we plumbers prefer to be called).

The existence of a large aerodynamic air compressor from which compressed air may be bled in quantities suitable for cabin ventilation and refrigeration is characteristic of all aircraft gas turbine powerplants. This fortuitous circumstance has resulted in the use of air-cycle cooling systems. Although the possible combinations are myriad, all air-cycle systems share the principle of using the expansion of air in a turbine to reduce its temperature substantially below ambient values.

Other means of cooling airplane cabins than the air cycle might be used. So far, however, weight and bulk have strongly favored this plan. Rockets or ramjets for propulsion present different problems, since the compressor is no longer available, and the air cycle may have less advantage in these cases.

Basic Problem

Since this paper is mostly concerned with the problems of the present and near future, it is largely confined to consideration of those aircraft in which a source of compressed air is available and used with an air-cycle system for cockpit cooling.

Let us consider a single-man fighter airplane. The pilot's enclosure is an oddly shaped box of 30-70 cu ft capacity. (A box 5 ft long and 3 ft square would be comparable.)

Imagine a man sitting in such a box out in the desert at noon in July. The upper portion of the box is transparent so that the sun's radiation pours in and, if filled with water pipes, probably could make steam. As if that were not enough, our airman finds that the airplane designer has provided his box with various heaters that he cannot turn off: radio, radar, lights, and hydraulic equipment add up to the equivalent of a good-sized bathroom heater in our transparent box in the desert.

But why can he not just open a window and turn on an electric fan? Unfortunately, the desert air itself may be 150 F. This is hotter than most deserts, but even if the atmospheric air is 110 F, an airplane flying through it at 500 mph will experience an increased air temperature due to ram effect. (See Fig. 1.)

If the above picture of discomfort is not adequate, consider the fact that the poor aviator is likely to be wearing the equivalent of a fur coat in flying clothes. Wearing light clothes is dangerous if high-altitude flight is included in the mission; if he has to bail out at high level, he can freeze to death in his parachute.

In actual fact, cockpit temperatures of over 150 F have been recorded with an atmospheric temperature of only 80 F. Obviously, human endurance can be exceeded. If high-speed flight at low altitude is contemplated, the airplane designer *must* include cockpit cooling in his plans. It is just as important as armament to military operations.

Basic Solutions

The simplest system of cockpit cooling, which has been used in wartime piston-engine fighters, is that of carrying along some ice. Dry ice is preferable, since less weight is required.

Another solution is to adapt the vapor cycle of the household refrigerator to the job.

The above plans fade out when the magnitude of the job is appreciated. Weight and bulk con-

Of Military Aircraft

siderations greatly favor the use of air expanding through turbines in some form or another. This conclusion is reached in spite of the greater power required for air-cycle cooling. The relative advantages of the air-cycle systems are far greater for high-speed military applications than for passenger planes with piston engines.

This paper is limited to air-cycle systems that bleed their supply of compressed air from the compressor of a gas turbine. Systems operating from ram alone or supplying their own compressed air belong to separate fields. The latter type is now in use for transports. Perhaps conditions will change, but the bleed-off systems look best for the problems with which we are now faced.

Air Conditioning Problem

If we were to set an ideal goal, it might be to have a cabin temperature adjustable between 65 and 80 F, with relative humidity controllable between 20 and 50%. This goal would have to be met with effective ambient temperatures from 150 to −65 F, and true ambient humidities from 5 to 100%. We must thus be able to heat air, cool air, add moisture, subtract moisture, and provide a sufficient ventilation rate of fresh air.

In practice, bleeding of hot air from the jet engine compressor seems to take care of heating, and adding of moisture seems to be out of the question because of additional weight and bulk involved. Furthermore, subtraction of moisture to reduce cockpit humidity is not yet being used in military aircraft. This would seem to limit the really complicated plumbing to the refrigeration job.

If the criterion is an endurable condition, and it is presumed that any actual low-altitude atmospheric condition is endurable on the summer-temperature side, it would appear that a system that will reduce cabin temperature to the true ambient value is acceptable for extreme design figures. This implies that no moisture need be separated, since practical ventilation rates are so high that moisture addition by personnel may be neglected.

The choice of design conditions involves a thorough understanding of the airplane and its intended uses, and superficial analyses will result in bad systems, regardless of the merits of the equipment applied. In the design of a system, it is necessary to select the following conditions:

1. Highest atmospheric temperature at sea level likely to be encountered.
2. Highest airplane speed compatible with No. 1.
3. Highest ambient relative humidity compatible and coincidental with No. 1.
4. Highest acceptable cockpit temperature compatible with Nos. 1, 2, and 3.

For a given set of selected conditions, the following can be determined:

1. Heat flow from airplane skin to cockpit by conduction.
2. Heat added to cockpit by solar radiation.
3. Heat rejected to cockpit by accessories (lights, radio, and the like).
4. Heat rejected by personnel.

The sum of the above constitutes the refrigeration load if no moisture is removed from the supply air.

If it is desired to reduce cabin humidity by moisture removal, the heat of evaporation of the separated water is added to the load, so that a rapid increase in load can result. This method of calculating load differs slightly from commercial practice, but is convenient in dealing with air-cycle systems.

Much has been said about environmental tem-

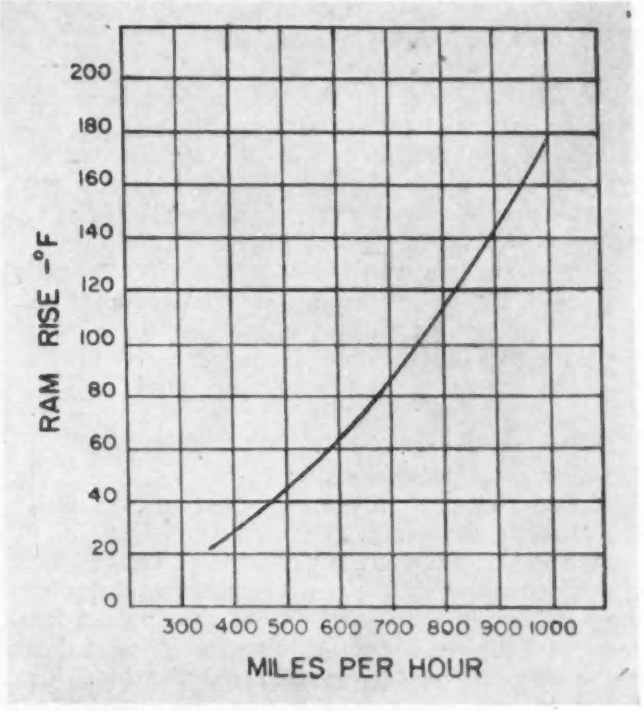


Fig. 1 – Variation of ram temperature rise with speed

*"Air Conditioning of Turbine-Propelled Military Aircraft," by H. J. Wood, project engineer, AiResearch Mfg. Co., was presented at the SAE National Aeronautic Meeting, Los Angeles, Oct. 3, 1946.

perature, and controversy rages as to just what is a comfortable or endurable condition. The airplane designer should study the literature in this field before selecting a cockpit air temperature, since humidity, air circulation, and radiation exposure are all involved. The advantages of adequate insulation increase when the influence of wall temperatures on comfort is appreciated.

Practical Cooling Problems

Once the air conditioning refrigeration load has been established by the airplane designer, the equipment engineer can provide devices to do the job. The number of possible air-cycle systems seems to be limited only by the ingenuity of inventors.

All air-cycle systems contain some or all of these basic elements: expansion turbines, heat exchangers, aerodynamic (axial or centrifugal) compressors, and fans (axial or centrifugal).

1. The simple system is the only one known to the writer to be now flying. A typical application is shown in Fig. 2. Air bled from the gas turbine compressor is first cooled to something approaching the effective ambient temperature in an air-to-air heat exchanger. Then the air is expanded to cockpit pressure in an expansion turbine, resulting in a discharge temperature substantially below true ambient. Power from the turbine is used to pull cooling air through the heat exchanger without ram assistance by means of a fan. If ram pressure is available for coolant flow, the fan pressure rise can be used to minimize drag in the coolant system.

2. The bootstrap system has two heat exchangers, both of which depend on ram for coolant flow. Each heat exchanger brings the bleed air down to something approaching effective ambient temperature, and power from the turbine drives a compressor *between* heat exchangers. This compressor increases the pressure drop across the turbine, resulting in a lower discharge temperature than for the simple system. This is accomplished at the expense of drag in the coolant circuit.

3. The regenerative system has two heat exchangers, but does not depend on ram for cooling airflow. It is essentially a simple system in which a portion of the turbine discharge air is used to cool the air entering the turbine below effective ambient temperature. It would be used when discharge temperatures of a simple system are too high for practical cooling.

4. The reduced ambient system is similar in function to the regenerative in that it seeks to reduce the temperature entering the turbine below effective ambient values. An expansion turbine in the cooling air entrance reduces the coolant temperature. This, of course, permits a lower heat exchanger output temperature for the bleed air. Pressure drop across the coolant turbine is provided by ram and the suction effect of the fan. Power for the fan (which is really a low-pressure compressor here) is taken from both turbines.

5. The shoestring system is a combination of the bootstrap and regenerative plans. Coolant to the primary heat exchanger is supplied by ram. The secondary heat exchanger uses a portion of the turbine discharge air as coolant, but this cooling air is recompressed and fed back to the system. Power for the compressor is supplied by the turbine.

Capacity of Air-Cycle Systems

For a given set of design conditions, the system will provide a definite amount of air at a definite turbine discharge temperature if the air is dry. These values are readily calculated if efficiencies of components are known. Capacity is based on this dry air rated discharge temperature and the mass airflow.

The assumption of dry air is not justified in service; however, as long as the dry air rated temperature is above the dew point of the atmosphere, no problem is introduced. Unfortunately, in the majority of cases, it is below the dew point. In such case, the turbine discharge temperature is not depressed to the dry air rated temperature, due to precipitation of moisture in the form of fog. Tests have shown conclusively that the resulting temperature is the same as may be calculated by assuming that the air is first undercooled to the dry

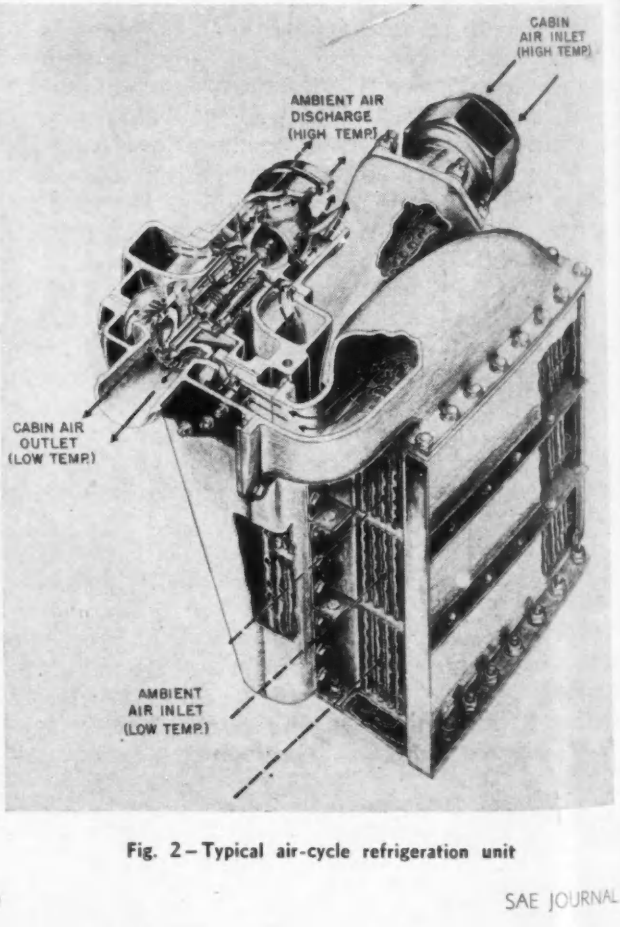


Fig. 2 – Typical air-cycle refrigeration unit

air rated temperature and then raised by an amount equivalent to the moisture precipitates. In fact, observations indicate that this is the actual physical process, since fog forms in the discharge at some distance from the turbine wheel.

Refrigeration capacity of a turbine is independent of water precipitation and may be based on the dry air rated discharge temperature. Obviously, this implies that all of the entrained fog can be reevaporated. If a portion of the fog is trapped and not allowed to reevaporate, the corresponding heat is added to the load.

As a practical problem, it has been found very difficult to separate fog precipitated in a turbine discharge from the air stream. Droplet size is so fine that precipitation or filtration is not readily accomplished. For the same reason, reevaporation is very fast. Accordingly, unless it is worth serious penalties in weight and bulk, military aircraft installations should not attempt to separate water from the cabin air supply.

Criteria for Choice of Systems

From the airplane designer's standpoint, the equipment, for a given capacity and set of design conditions, must minimize: weight (including ducting), drag, bulk (including ducting), and complication.

These objectives often are conflicting. In military aircraft, bulk has seemed to be the worst problem, and the other three are usually compromised to fit some odd space. As speeds go up and cooling gets more difficult to provide, it is likely to prove necessary to give the refrigeration equipment a higher priority in assigning space.

Notably missing from the above list is the minimization of jet engine air bleed. Usually, some arbitrary bleed limit is set for a given engine, and this is based on extreme altitude and expressed in pounds per minute. Such limitations are artificial. A better plan would be to express the bleed limit in terms of percentage of main compressor airflow. Any air-cycle system with fixed throttle and nozzle settings will tend to bleed a constant percentage of compressor flow, regardless of flight conditions. In practice, the amount of air bled for air-cycle systems has always been much too low to affect engine performance, even with axial-flow compressors. The criterion of minimization of total drag does include the drag that may be attributed to bleeding of engine air.

The choice of system is likely to depend on: design cabin air temperature, airplane speed (as reflected in effective ambient temperature), compressor ratio of turbine, and available space.

As airplane speeds increase, turbine discharge temperatures of all systems tend to rise. As discharge temperature approaches the cabin air value, the capacity reduces rapidly. The utility of the simple system reduces rapidly above 600 mph. When it is modified to make a regenerative system, any lower discharge temperature may be achieved by varying the amount recirculated.

Table 1 – Comparison of Air-Cycle Systems

System	Cooling Air Supply	Ground Cooling	Cooling Air Drag	Bleed Air Drag	Notes
Simple	Fan	Yes	Low	High	Simplest to build and install. Not desirable over 600-650 mph
Regenerative	Fan	Yes	Low	High	Simple to build and install. Used for speeds over 600 mph
Bootstrap	Ram	No	High	Low	Requires large cooling airflow. Good where pressure ratio is limited
Reduced ambient	Ram	Slight	Medium	Medium	Mechanically complicated
Shoestring	Ram	No	Medium	Medium	Possibility for high speeds and high pressure ratios

Another factor that limits choice of systems is the matter of freezing of moisture in the turbine discharge. It is quite possible to form ice with available systems at humidities commonly encountered. Although fog will not precipitate, the fine ice particles that form in the turbine discharge will deposit as frost and clog the duct. This phenomenon has been observed in flight with a simple system. As altitude increases and ambient temperatures drop, the dry air rated temperature drops too. It is not certain just how low a dry air rated temperature may be designed for extreme conditions without resulting in icing troubles under less-severe flight operations. Present experience leads us to the conclusion that 10 F is the minimum usable dry air rating for most-severe operations. However, it is possible that −10 F is a practicable value.

Relative weight and bulk of the several systems considered are hard to evaluate. Our own conclusion is that systems which depend on ram and have relatively large ratios of cooling airflow to bleed airflow will suffer when the whole installation is considered. As noted previously, the cooling equipment usually inherits left-over space, to which it is often difficult to get ram ducts of adequate size.

Pursuing the matter of location further, since the simple and regenerative systems will operate without ram, they offer more freedom in making installations and may sometimes prove to be the only practicable choice.

So far we have discussed only cooling in flight. If we consider our box in the desert again, it is seen that it could be quite uncomfortable if the desert temperature were only 100 F. We find the provision of ground cooling by the simple system tc be much appreciated in airplanes now flying. This circumstance is a point in favor of the simple and regenerative plans.

If any conclusions can be drawn to date, they are as follows (see Table 1):

1. The simple system is preferable up to speeds of 600-650 mph, above which the drag penalty is too high.

2. The regenerative system is the best choice at speeds above 600-650 mph, with the bootstrap as a close competitor. Installation considerations and

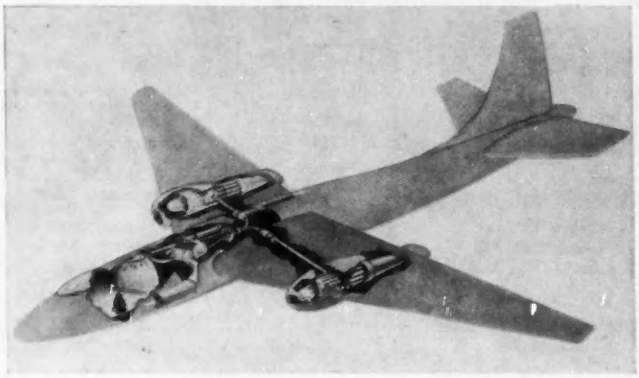


Fig. 3 – Ideal air-cycle system installation

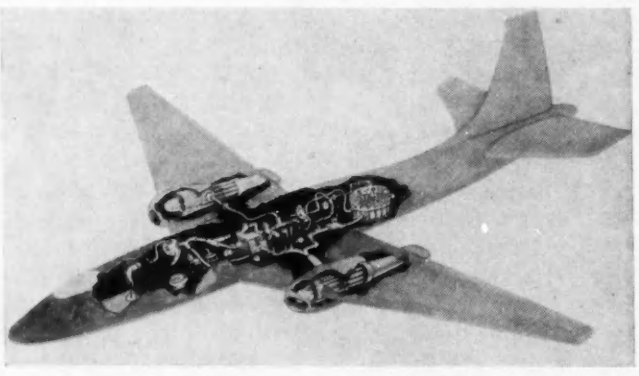


Fig. 4 – Slightly exaggerated version of a practical installation

ground cooling favor the regenerative plan. At very high speeds, the high pressure ratio of the bootstrap turbine introduces complications.

3. The reduced ambient system involves mechanical complications, and difficult design problems. It will probably prove of use for ramjet and rocket propulsion planes.

4. The shoestring system may have merit if bleed air rates are limited and speeds are very high.

Practical Installation Problems

At the present time, we are dealing with rotative speeds up to 100,000 rpm and achieving turbine efficiencies of 79%. Further improvements in efficiency are expected. A less spectacular component is the cooling air fan. Because of the relatively large volume of coolant flow, very high flow factors must be built into very small rotors. This factor is readily overlooked in installations, where provisions for ducting the cooling air to and from the unit have sometimes been inadequate.

The resultant drag penalty of a cooling system is as much in the hands of the airplane designer as the equipment engineer. It is up to him to provide ducting for the bleed air and cooling air circuits, and much may be lost in either.

Since the temperature drop in the air turbine is limited by the pressure ratio available, and the bleed air drag is proportional to the amount bled, it behooves the airplane designer to make best use of this air by minimizing the pressure losses in this circuit. The duct from the turbine to the cabin is particularly critical, since a pressure loss on the discharge side has more influence than on the high-pressure side. Furthermore, heat transfer into the discharge air has, by actual test, reduced the capacity of a system by 30% before the air ever reached the cabin. Since a differential of 150 F may exist between the inside and outside of the turbine discharge pipe, adequate insulation is difficult. The best plan is to keep this member short and straight. The sensitivity of a system to icing also is determined here.

Equally serious problems are encountered in the cooling air circuit. Fig. 3 shows an ideal ducting system and Fig. 4 shows something just a little worse than has been observed in practice. It is well recognized that in any internal flow system, the higher the velocity at which we can return the air to the slipstream, the lower will be the drag. Thus, the best plan appears to take cooling air in through a ram duct and eject it through a nozzle. If a system is used with an efficient coolant fan, the pressure at the nozzle could be high enough to get some thrust recovery. Thus, even though a system will operate without ram on the cooling air, drag may be reduced if ram is provided.

Because of the stratified nature of the heat load, careful consideration must be given to methods of introduction of air into the cabin. In early installations, the pilot complained continuously of sweating shoulders and frostbitten feet. On occasion, the cockpit floor was observed to be blanketed with fog and snow. Introduction of the cold air by diffusers near the pilot's shoulder is a good plan, but auxiliary circulation means may be necessary.

■

MOTOR BUS DEVELOPMENT

continued from page 56

safety, endurance, long life, or maintenance economy. Table 1 shows that only 16% of the total weight of an empty 41 passenger bus is body framing and panels, or less than *either* the powerplant or the rear axle assembly.

It has been found that for each 1% reduction in fuel consumption there must be a 2.75% reduction in bus weight (Table 2). The effect of weight-saving on improving schedule speed is even less impressive, when a 15% improvement requires a 10.5% reduction in weight, as seen in Table 3.

It is generally conceded that a rate of deceleration of 7 mph per sec is about the maximum that can be tolerated in a city bus. If this is reduced to a normal decelerating rate of 3½ mph per sec, this alone would improve fuel economy by 8.2%, and would reduce schedule speed by less than 6%.

AIR CONDITIONING in Cars Offers Home Comforts

EXCERPTS FROM PAPER **By T. C. GLEASON***

CONTINUED effort by the automotive industry to provide more comfort and luxury in its products has resulted in remarkable advancement in the application of air conditioning principles to automobiles.

For winter comfort, heat systems with effectiveness comparable to the best residential practice should be common to the automobile in the next few years. Fast warmup of air and adequate provisions to prevent fogging or frosting of the windshield and windows may be expected.

Summer comfort is also beginning to receive more serious attention, as evidenced by the public demand for an increasing number of cooling installations in commercial vehicles and buildings. These signs are not being overlooked by the automotive industry, and active development of cooling systems for passenger automobiles may be anticipated.

Objectives of around-the-year air conditioning for automobiles can be met, for the most part, by American Society of Heating and Ventilating Engineers standards.

Normal use of the automobile includes a large number of short trips, for which quick warmup of air is an especially desirable feature during the winter.

Experience indicates that the car heater should become fully effective within, at most, 3 min after a cold start.

The automobile presents an extremely difficult problem because of the close quarters within and the wide variation of conditions without. Five occupants, all of whom may be smoking feverishly, occupy a space of about 150 cu ft, and the supply of outside air may be vitiated by exhaust gas and dust.

It is probable that the elimination of outside odor will not receive consideration for some time, but dust extraction should be considered right from the start.

Within the car, experience indicates a minimum requirement of about 30 cfm of fresh air per person or a total of 150 cfm.

Moisture given off by occupants requires a sufficient supply of fresh air to prevent fogging of windows. In many cases the amount may not be equal to that required for air quality; but in any case the higher of the two should be used to meet both requirements.

A theoretical examination, based upon 0F outside, 70F inside, and five occupants, indicates that, if properly distributed, 160 cfm should prevent fogging. However, unless special ducting to the windows, or other special window treatment is introduced, experiments indicate a somewhat greater quantity may be required.

Windshield defrosting is another special problem to be included as a winter responsibility of the air conditioning system. A primary requirement is that the system should be capable of maintaining an ice-free windshield at all temperatures.

The need for defrosting normally occurs at temperatures at 20F to 32F, this being the usual range for sleet storms. Through the sleet storm range sufficient heat must be supplied to the windshield to maintain the outside surface of the glass slightly above 32F.

Limited experiment indicates that a minimum

* Paper "Car Air Conditioning," by T. C. Gleason, of Chrysler Corp., was presented at the SAE Detroit Section, Nov. 18, 1946.

of 1000 Btu/hr should be supplied to the windshield to meet this requirement.

An entirely different requirement is encountered at temperatures below the sleet range. Below 20F, the cloud fall is usually in the form of dry snow. Road conditions are often such that cars may proceed at high speed. The high heat input required to defrost the windshield under such conditions may not be available. From the practical standpoint, therefore, it is necessary that the windshield be kept at low temperatures so that snow will not melt and freeze.

Air distribution affects both local temperature and velocity. Incorrect values of either appear to be registered by the human physiological sense as a draft. It is suggested that temperature differentials in the occupied region should not be over 3F and velocities not over 50 fpm.

Normal air conditioning practice calls for substantially constant temperature throughout the occupied space. For extended driving periods, constant temperature permits removal of outdoor apparel and as a result tends to increase driving or riding comfort.

The car heating system should be capable of maintaining at least 70F inside with 0F outside.

The ASH&VE place a minimum acceptable relative humidity of 30% in the interest of comfort. But without special treatment to windows, it is practically necessary to accept relative humidities as low as 10% in the interest of safety through good visibility.

Summer Requirements

Demand for fast reduction in car air temperature in summer should be considered equal to the winter time demand of speed in warmup.

To meet the objective, the cooling system should become fully effective (produce design output) at low car speed. In addition, experiments indicate that the effect of solar radiation should be reduced during the parking period, to minimize the building up of interior temperatures.

Air quality and distribution values for winter heating may be considered applicable the year around.

In the treatment of stores, theatres, and restaurants, where occupancy periods are considered to be not over three hours duration, the ASH&VE recommend 80F inside when 95F outside is assumed. Considering the general use of the automobile, these figures are suggested as a commendable target for the cooling system.

A maximum of 50% relative humidity is recommended. Fortunately, most cooling systems are inherently good dehumidifiers so that values of 50% or less may readily be attained.

To meet these heating and cooling requirements a few specific conditions encountered in the car body must be considered.

Control of air leakage into the car body is a necessary part of the air conditioning problem. Infiltration (the random admission of outside air through cracks and holes in the body) may produce jets of unconditioned air impinging directly upon the occupant. Drafts, dust and general dissatisfaction may result.

Infiltration can most successfully be avoided by maintaining the occupied space at a pressure above that of the outside. For example, the car body can be sufficiently sealed so that at, say, 60 mph the quantity of outside air admitted by the conditioning unit is sufficient to build up the pressure required to prevent infiltration.

In general, insulation is already being applied to automobiles today for reasons other than for air conditioning. In fact the air conditioning engineer can be thankful that there has been an increasingly insistent demand for quiet automobiles, because many of his problems have effectively been reduced by the sound engineer. This has been done by the sealing up of holes and the addition of insulation which not only cuts down noise, but also generally proves to be fairly effective from a thermal insulation standpoint.

While air conditioning will require more insulation than commonly provided for sound proofing, an excellent start has been made. Also the penalty for insulation needed for air conditioning can rightly be divided between sound proofing and heat proofing.

For winter conditioning, the overall conductance factor for a 5-passenger automobile at 30 mph is in the order of 50 Btu/hr per deg difference in temperature between the inside and outside. At the same car speed, the overall conductance factor for summer conditioning is several times as great. The disparity between the winter and summer factors might be attributed to the heat added by such factors as the engine and exhaust system.

Summer conditioning requires that impingement of solar radiation upon the occupants be materially reduced below present car standards. Experiments indicate that use of solar heat absorbing glass or reflective glass, or both, furnishes a practicable solution. This type of glass also helps to reduce the parking load (if not over about 4 hr), promoting faster cool down.

Tests of an air conditioned car with clear glass indicate a solar transmission of about 1200 Btu/hr. Heat absorbing glass may be expected to halve that value. As far as the total load on the air conditioner is concerned, the saving is small. But, in terms of the physiological effect upon the occupants, the advantage is considerable.

Motor Fuels for Light Planes?

BASED ON DISCUSSION AND PAPER BY

Robert V. Kerley*

LIGHT aircraft engines *can* and *should* be designed to operate on readily available motor fuels, Kerley believes. Added costs of the better engineering and better materials required would be worth it, he contends, because utility of light planes would be greatly increased. They could be refueled as readily as an automobile.

Not everyone agrees. Aviation fuels are widely distributed now, the opposition contends—one man cites 200,000 miles of flying experience in light planes from Alaska to Mexico without need to substitute motor fuel. Even granting availability advantages if planes could use motor fuel, this group argues that far greater disadvantages would result. They say high vapor pressure of motor fuels steps up vapor lock dangers . . . lower boiling point may cause boiling in the carburetor and fuel metering problems. Besides, they add, motor fuels are produced under less rigid quality control and dealers are not so careful in handling them.

Recognizing these problems, Kerley maintains that the availability advantage of using motor fuels outweighs the difficulties which might accrue from their use. He admits the volatility problem is difficult, but believes it can be solved. Other supporters of motor fuel point out that its higher 50 and 90% points allow evaporation to occur progressively throughout the induction system rather than to localize at the throttle where it may result in carburetor icing at low temperatures. Another advantage they note is the seasonal adjustment of volatility – an advantage to be enjoyed only with motor fuels' rapid turnover and quantity handling. (It is general practice to manufacture motor gasolines having increased front-end volatility for cold-weather use.)

Kerley denies charges that variations in quality of motor fuels preclude their use in aircraft. He cites for example the National Motor-Gasoline Survey which reported remarkable uniformity of antiknock rating even during wartime. In reference to the contamination issue, he asks what better protection is to be had against contamination by water, rust, scale, sand, paint, and gum than settling in large tanks like those of the average service station. Others add that deterioration is less, too, with such quantity handling. There is less chance for slow oxidation of hydrocarbons and evaporation of the lighter fractions.

Kerley bolsters his statements that light aircraft engines can be operated on motor fuels with service and laboratory experience. During the war, light liaison planes were run when necessary on Grade-80 all-purpose fuel, essentially a motor fuel. It is true that complaints of valve-sticking, combustion-chamber deposits, and valve corrosion were far too numerous for the comfort of pilots, but these difficulties have been satisfactorily eliminated by subsequent development work.

Lycoming licked the problem of valve sticking in its 0-435 engine by counterboring the standard valve guides.

Tests made by the Ethyl Corp. showed that combustion-chamber deposits were actually less with motor fuel than with leaded aviation fuel. Comparison was made with ethyl 1-T aviation-mix and 62 motor-mix fluids. Deposits were greater with the aviation mix combined either with 2-103B prototype motor fuel base or with aviation fuel base. Although there were indications that 2-103B prototype fuel, independent of ethyl mix, caused more corrosion pitting, this may have been due to its lower octane rating. Other investigators have reported that, even with aviation fuels, greater corrosion accompanies use of low lead-content products.

Brightray valves with sodium-cooled stems and increased lubrication just about licked the corrosion problem. Only a trace of etching was noted on their heads and stems. Lubrication was increased by installing a dam between the valve cover and cylinder head which permitted the oil level to build up to the centerline of the exhaust-valve stem.

Mr. Kerley's paper, and discussion which followed its presentation at French Lick, will be printed in full in an early issue of SAE Quarterly Transactions.

Here is given a brief summary of some of the important points brought out on both sides of what turned out to be one of the most interesting arguments of any SAE session in recent years.

* Paper "Light Aircraft Service Experience with All-Purpose Fuel," by Robert V. Kerley, Ethyl Corp., was presented at the SAE Summer Meeting, French Lick, Ind., June 4, 1946.

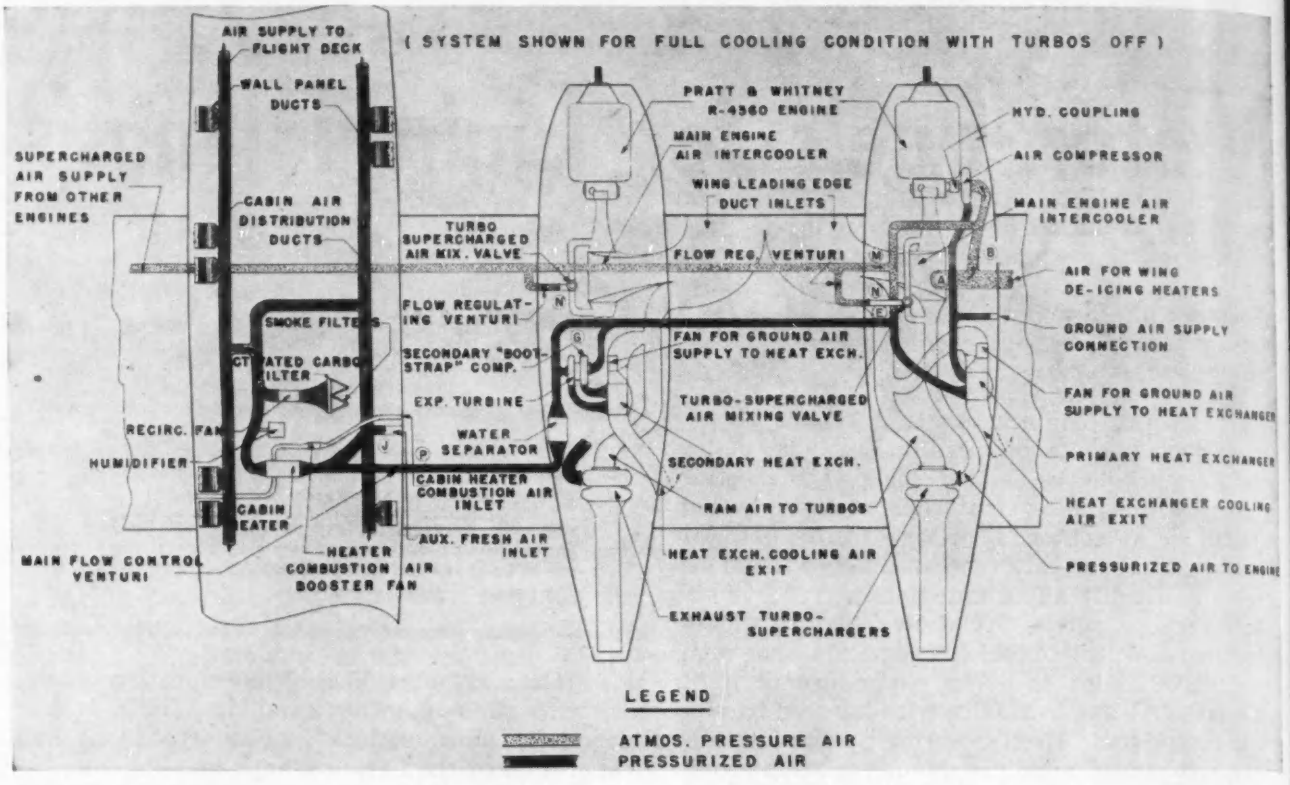


Fig. 1 – Shown here is the operation of the Republic Rainbow's air conditioning and pressurizing system during full cooling

RAINBOW AIR

MAINTAINING passenger comfort on a par with that of other modes of transportation is a major problem facing builders of high-altitude high-speed commercial airplanes. Only when this is accomplished will the speed of air travel become a truly competitive selling point.

Although many solutions to the problem suggest themselves, the air conditioning and pressurization system designed for the Republic Rainbow represents one successful approach. Typical of tomorrow's air transports, this 4-engine airplane cruises at between 400 and 450 mph at 40,000 ft, and has a range of over 4000 miles. It carries 46 passengers and the payload for a 4000-mile flight is 10,000 lb.

Turbosuperchargers on each engine (for power at high altitudes) are an excellent source for pressurizing the Rainbow's cabin and heating the air supply. But at low altitudes, the turbos are bypassed to permit the required climb powers.

This necessitates an auxiliary air compressor for pressurization at low altitudes which serves as a practical foundation for the airplane's air cycle refrigerating system. But once altitude is reached, the turbosuperchargers are again cut in for pressurizing and also to supply pressure air to the expansion turbine in the air cycle system.

Advantages of this arrangement are at least three-fold.

First, requirements of the auxiliary compressor are greatly reduced since it pressurizes the cabin up to a relatively low altitude instead of 40,000 ft. This permits a smaller unit and draws less power from the engines at cruising altitude.

Second, compressor life is lengthened as the compressor operates only for short periods of climb or descent at low altitudes. This factor lightens the maintenance load; it can mean the difference between cancelling or delaying a flight and sending it through on schedule.

Third and most important, cabin pressurization in this system is not dependent on a single compressor but on four separate sources of supply. Any two turbos supplying required airflow can still provide adequate pressurization, even if the other two engines are inoperative.

Here is still another point. Since the pressure ratios for engine supercharging are higher than those for cabin supercharging, temperature rise through the turbo is greater than that through a cabin compressor. Thus the turbo is a better

*Paper "Factors Affecting the Design of the Air Conditioning and Pressurizing System for the Republic Rainbow Airplane," by P. E. R. Brice, Chief Powerplant Engineer of the Republic Aviation Corp., presented at the SAE National Aeronautic Meeting, Oct. 5, 1946.

source of heated air, reducing required capacity of auxiliary cabin heaters and saving space and weight.

Shown schematically in Fig. 1 is the Rainbow's air conditioning and pressurizing system in operation for full cooling, at low altitudes, with the turbosuperchargers by-passed. Let us follow the air through this maze of equipment as it travels from the outside to the cabin interior.

Air for the primary compressor on the No. 4 engine is brought from a diffuser duct leading from the wing inlet duct to the front face of the main engine intercooler at A. After passing through the check valve at B and being compressed by the compressor, the air is passed through the primary heat exchanger to remove most of the heat of compression.

In travelling to No. 3 nacelle, a check valve at E prevents the air from by-passing back to the compressor. Next step in the process is passing the air through a secondary or boot compressor and then through a secondary heat exchanger. The air then expands and is cooled in passing through the expansion turbine.

Since the air at A – due to its higher temperature – can hold more moisture than the air at the expansion turbine exit, condensation will take place at the turbine exit. If carried into the cabin in this condition, air will deposit condensing vapor directly on passengers and upholstery. For this reason air passes through a water separator.

Next points of interest in the air treatment journey are the main flow venturi and cabin heater (which is off during cooling). Treated fresh air then mixes with recirculated air that has been drawn by a fan across smoke and dust filters and activated carbon filter for freshening.

The fresh and recirculated air mixture is distributed through ducts under the cabin floor to many panel ducts from which it is exhausted into the cabin at substantially cabin temperature.

Cabin pressure is controlled by two regulators in the fuselage that are set to maintain any cabin altitude from slightly below sea level to 15,000 ft. Rate of pressure change is provided by these regulators so that the rate of altitude change in the cabin can be maintained as low as 200 fpm – even if the airplane is ascending or descending at much higher rates.

Result of such a rate-of-pressure-change control on cabin altitudes during a typical flight plan is shown in Fig. 2.

Solid lines show that without this control, airplane climb and descent rate between sea level and 8000 ft – or whatever altitude the cabin is to be held at – must be kept to a maximum of 300 fpm for passenger comfort considerations. This means extra time consumed in flight with a corresponding reduction in block-to-block speed.

But with rate-of-pressure-change control, dotted lines, the airplane can climb or descend at its optimum rate; yet the cabin altitude rate can be maintained as low as 200 fpm. Not only does this tend to increase passenger comfort, but it also increases block-to-block speed.

CONDITIONING

FROM A PAPER **By P. E. R. BRICE***

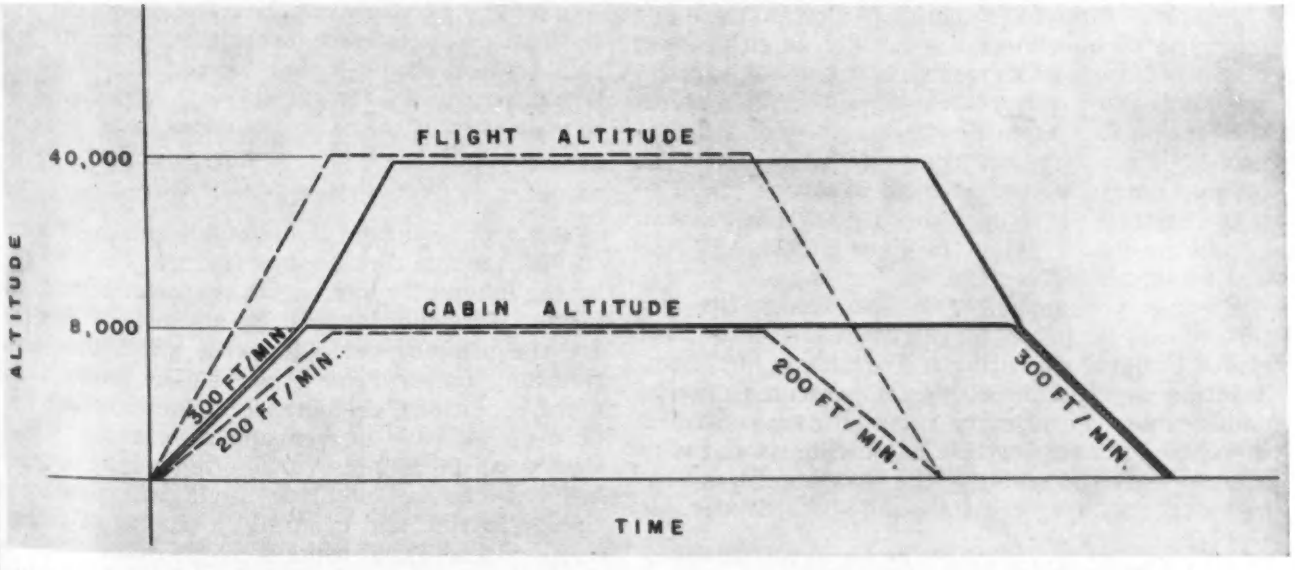


Fig. 2 – Controlling the cabin rate of pressure change permits faster airplane climb rates while maintaining a reasonable level of passenger comfort

Automatic Controls for Gas T

BASED ON A PAPER BY

C. W. Chillson, G. P. Knapp, and M. Meyer*

OPERATING requirements of automatic controls designed for turbopropeller powerplants are considered by the authors, who declare that the control problem is not a simple one because of the large number of variables for both powerplant and propeller that must be considered. Stability requirements as well as the operating requirements of the turbine-propeller combination dictate the manner in which these variables can be employed. Operating requirements and limitations are discussed by the authors as follows:

Operating Requirements

Fundamental Limitations – In gas turbine type powerplants, the performance is fundamentally limited by the rpm at which rotating elements can safely operate and the maximum safe temperature for the elements exposed to combustion gases. Normally most critical because they are subjected to both high temperatures and high centrifugal forces are the buckets on the turbine wheel.

Primary Control Functions – Power available from the turbine increases rapidly as either rpm or temperature is increased, so that for take-off and combat operations, closely controlled operation at the maximum limits of rpm and temperature is of great importance. Fuel economy of the turbine normally increases at the same time, so that maximum cruising economy will, in general, be obtained at greater fractions of take-off rpm and power than for reciprocating engines.

Because primary stresses are steady, the materials can be operated relatively close to their elastic limits at operating temperatures, but short-duration overspeeds or overtemperatures may be undesirable. The primary function of a control is therefore to control within narrow limits and with a high degree of stability the maximum temperature and rpm over the full range of altitudes, air temperatures, and air speeds that will be encountered. A supplementary function is to maintain temperature and rpm at less than maximum, it being conceived that the pilots control should, in effect, be calibrated in terms of percentage of maximum permissible rpm and temperature, with corrections for changes in altitude, air temperature, and air speed, operating to maintain these percentages approximately under all flight conditions.

It has been suggested that provision be made for taking air from the compressor for cabin supercharging and heating and for hot-air de-icing of aerodynamic surfaces. Battle damage in the form of holes in the powerplant between the compressor and the burners has the similar effect of providing less air to the burners and consequently making less power available to the propeller at any specified turbine temperature. Axial-flow compressors, especially, are potentially subject to changing characteristics with use. If the power control is not controlling temperature directly, it should also, therefore, be relatively insensitive to variations of this type or should include correctives that effectively compensate for variations in the amount and temperature of air being delivered to the burners.

Variables To Be Controlled

The problem of obtaining stable and precise control of rpm and turbine temperature is complicated by the inherently interactive characteristics of the system. Propeller blade angle and rate of fuel flow are the primary variables with which to control rpm and temperature. Under steady ambient and flight conditions, an increase in fuel flow will produce an increase in rpm and also, at least transiently, an increase in turbine temperature. Similarly, a change of blade angle will produce a change in rpm and generally a change of turbine temperature. Thus, while a single automatic control operating on either blade angle or fuel flow could be made to control either rpm or tempera-

* "Automatic Control Considerations for Aircraft Gas Turbine-Propeller Powerplants," by C. W. Chillson, C. P. Knapp, and M. Meyer, Propeller Division, Curtiss-Wright Corp., was presented at the SAE National Aeronautic Meeting, Los Angeles, Oct. 3, 1946.

Turbines

ture stably, changes in the setting of the controlled variable would result in changes in the uncontrolled variable. If two such controls were operated simultaneously to control both rpm and temperature, a correction of one control would create a disturbance in the other. This process could result in unstable operation of the system, even though each control, when operating alone, might produce stable operation.

Requirements Imposed by Various Flight Regimes – Starting: Before the power relations between the compressor and turbine become such that the powerplant will drive itself, it is necessary to get it up to approximately 50% of rated rpm. Because of the relatively large amount of power required by the compressor at this rpm, the problem of starting is a serious one and requires a starter of relatively high output. To reduce the overall requirements to a minimum, it will be desirable for propeller pitch to be adjustable to an angle corresponding to minimum torque.

Take-off and normal flight: The amount of power available for driving the propeller by a typical gas turbine powerplant without exceeding the permissible rpm and temperature varies widely with air speed, altitude, and ambient temperature (Fig. 1). Since the reduction gear already represents a substantial portion of the total powerplant weight, it may not be practical to design it to have sufficient capacity to meet all possible conditions. On cold days with a control that merely limits rpm and temperature, a shaft horsepower might result that is greatly in excess of that for which the propeller reduction gearing might logically be designed. It may, therefore, be necessary for the control to limit the torque output to an acceptable value.

Landing and dive braking: The moment of inertia of the rotating parts is very high, so that, with the torque available for acceleration and deceleration, a number of seconds is required to accelerate from 70% rpm (output substantially zero) to full rpm. For landing it is desirable to postpone as long as possible the instant at which the aircraft is definitely committed to land, so that it is desirable to maintain power close to full rpm during the entire approach, thus allowing power to be applied with minimum delay.

As air speed is reduced during the approach, a considerable change in thrust takes place at any fixed pitch setting. It is therefore desirable that propeller blade angle be automatically controlled to supply at maximum rpm substantially zero thrust during a landing approach. When the propeller is used as a landing brake, additional power control movement should provide a corresponding per cent of available negative thrust.

At high air speeds it is possible to obtain substantially greater values of negative thrust than the maximum positive thrust that is obtained under static thrust take-off conditions. The propeller blade and retention structure is generally designed so that short-duration stresses appreciably in excess of allowable continuous stresses may be tolerated. As the air speed increases, however, the amount of negative thrust available can conceivably become great enough to cause failure in a propeller blade of reasonable weight and strength. It may, therefore, be desirable for a control to limit the negative thrust to a value less than the maximum available at some air speeds.

Additional factors must be considered if it is planned to use the propeller as a dive brake at high speeds. For a typical turbine and propeller, above about 200 mph at sea level, it is possible for the propeller to produce sufficient power as a windmill to drive the powerplant in excess of its permissible speed, even though the fuel flow is entirely shut off and the burners extinguished. As altitude increases, the amount of power that the powerplant will absorb (compressor driving power less turbine recovery) decreases substantially, with the result that, while at sea level a substantial negative thrust is obtainable with the burners still lighted, at 35,000 ft only a relatively small amount of negative thrust can be absorbed by the pro-

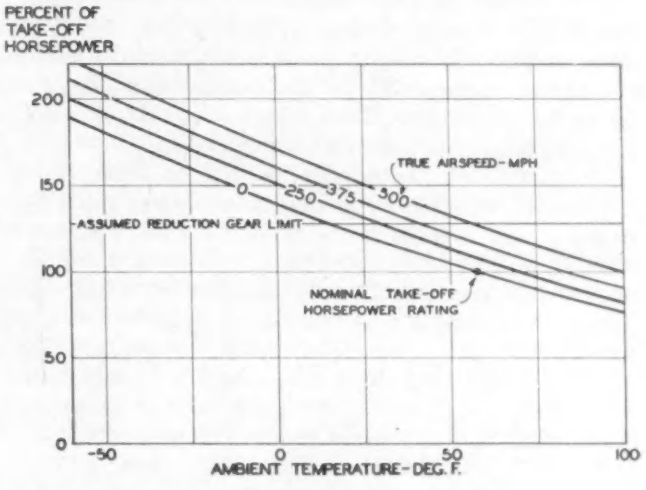


Fig. 1 – Maximum turbine shaft horsepower as a function of air speed and ambient temperature for sea-level operation

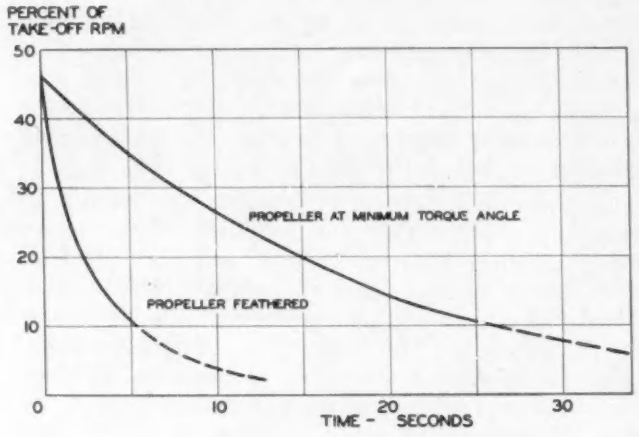


Fig. 2 – Powerplant deceleration characteristics – power off

peller before it causes the powerplant to overspeed. With dive-braking propellers on conventional engines, which can absorb only small amounts of power, it has been the practice to reduce the pitch very rapidly through the windmilling range to prevent overspeeding. This alternative is also available with a turbine propeller. It may be possible, however, to obtain operation that imposes excessive propeller blade and/or reduction gear stresses while the propeller is still in the windmilling blade angle range. For dive braking installations a special control may be required that prevents the pitch from reducing to a point where the burners are extinguished, or that permits initiation of rapid pitch change through the windmilling region only when the negative thrust, at the reduced blade angle that must be reached to avoid excessive windmilling rpm's, will not be great enough to overload the propeller destructively. In conjunction with a control that prevents burner extinction, some means for absorbing additional horsepower in the compressor may be desirable to provide more effective braking, especially at high altitudes and air speeds.

Stopping and feathering: Friction losses in a powerplant of this type are relatively small. On stopping, the inertia of the powerplant is sufficient to cause it and the propeller to continue to rotate for several minutes. It may be stopped more rapidly if the propeller is feathered, which will not only reduce the time required to decelerate the rotating parts but will also reduce subsequent windmilling. Fig. 2 shows approximate stopping times with the propeller feathered and with the propeller in minimum torque pitch. The rate of feathering may have to be limited because of the large amount of kinetic energy stored in the rotating elements at normal operating speeds. If an attempt is made to dissipate it too rapidly by feathering, excessively high stresses may be produced in the turbine reduction gearing. The same torque limiting control recommended previously might well serve in this instance as well. Decelerating by feathering will also result in a substantial amount of thrust as the blades pass through their working range on the way to the feathered position. This may impose a further limitation on the feathering rate or it may be necessary to allow the powerplant to slow down appreciably before starting the feathering operation, should it not be convenient to restrain the aircraft momentarily against approximately the full static thrust of the decelerating powerplant.

The characteristic increase in fuel economy with increased power output considerably alters the power balance that is optimum for cruising efficiency. The fact that maximum airplane aerodynamic efficiency occurs at less than maximum speeds and powers has customarily coincided with reciprocating powerplant fuel consumption and propeller efficiencies resulting in maximum cruising efficiency at less than full engine hp and rpm. This is not true to the same extent for the turbine-propeller combination. A relatively simple recourse available to improve economy in multiengine aircraft is to operate with some of the engines operating at full horsepower output and with the remainder stopped and propellers feathered. As is customary with reciprocating engine installations, it may also be desirable to feather the propeller in flight to stop propeller and powerplant rotation in the event of some types of failure.

Windmilling Sets Up Engine Torque

In reciprocating engines the blade angle for a feathered propeller corresponding to zero rotation also corresponds to minimum propeller drag. For turbine powerplants, however, appreciable torque is produced in the powerplant by windmilling action, especially at high airplane speeds. This is most pronounced in engines with axial-flow compressors. If rotation is to be stopped completely, it is, therefore, necessary either to supply some sort of brake or to increase the feather angle setting so that the propeller is producing enough torque in the reverse direction to counteract the windmilling torque of the powerplant. While the feather angle so selected will not correspond to minimum drag, the importance of such increased drag as is produced will depend on the specific application. There are insufficient data available to permit the statement of generalized conclusions. Since it is possible that its angle will vary with flight conditions, it may be desirable to incorporate an automatic control to readjust the pitch as required to maintain the normally rotating elements substantially stationary. It is possible that an oil pump brake might be adapted to overcome such small torque variations and keep the propeller stationary.

EXPENSIVE WEIGHT SAVING

FROM A PAPER BY **B. J. VIERLING** AND **LAN H. CALDWELL***

WRONG-WAY weight saving in transport plane design can reduce passenger appeal, up maintenance costs, and decrease operational efficiency. Judiciously added weight can be a revenue-producing investment.

A pound saved will always increase payload – but it may reduce net income. Poor ventilation and leaky window frames may turn passengers away. Lack of primer coats on some interior parts may increase inspection cost, permit corrosion. Added weight of all-weather instrumentation may turn losses into profits during winter months... In all three areas – passenger appeal, maintenance costs, and operational efficiency – weight saving may be at the expense of net profits unless designers elect proper compromises.

Passenger appeal can be decreased considerably by lightly constructed door sills which wear quickly and may cause falls... by laminated cabin floors which become spongy after short periods of service... by plywood doors which become shabby and noisy – and often have to be reworked, strengthened, and insulated against rattling... by lightweight frames for windows and windshields, which leak rain on passengers and annoy pilots. In many other ways inadvisable weight-saving may cut revenue by decreasing passenger appeal.

In one 40-passenger plane, for example, weight saving was achieved by using a skimpy ventilating system. Summer temperature inside the cabin soared to 100 F on the ground, smoke and foul air hovered over the passengers. Few people cared to travel under those conditions. A better, 10-lb-heavier ventilating system was installed – even though flight schedules had to be interrupted to put it in. Only 42 additional passengers a year had to be attracted on trips averaging 300 miles to pay for the extra weight. It would have been much easier and less expensive to install the new system at the time the plane originally was reconverted from military to civilian use.

A few pounds can be whittled off by using a certain very light model of ash receptacle, but this model is so hard to open and close that passengers snuff out their cigarettes on the carpeting. Besides dirtying the plane and raising cleaning expenses, this practice is a fire hazard. Two ounces more per passenger invested in the ash receiver will eliminate these troubles.

Lightening May Up Maintenance

Eliminating the 50 lb of primer used on interior surfaces of an average plane prepares the way for corrosion of aluminum surfaces, especially where cleaning and inspection are difficult. About 35 lb can be saved by omitting fittings needed to make wing sections removable. (But, in case of damage, the entire wing may have to be replaced at a cost of about $8000.)

Omission of occasional hand holes may necessitate a "butcher" job for such a simple operation as replacing a rivet or installing a reinforcement.

Weight saved on exhaust stacks can be particularly expensive. Too short exhaust tail pipes offer chances for fire and corrosion damage to the entire aircraft, and especially to de-icer boots. Installation of antirotation clamps minimizes ball joint wear and fire hazards.

Capital Airlines has found it well worth 4 lb to increase the period between brake inspections from 150 to 850 hr by adding a 4-lb hydraulic self-adjusting brake clearance valve to a new type DC-3 brake.

Substitution of integral wing tanks for the old type fuel tanks reduced reliability and revenue as well as weight and space requirements. One operator reports repair needs on the new tanks resulted in 94 days on the ground out of 940 operating days.

During the winter months, installation of thermal anti-icing and blind-flying equipment might spell the difference between profit and loss. Although the equipment adds weight, it would practically eliminate flight cancellations due to unfavorable weather and landing conditions.

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*Paper "Weight Saving Can Be Expensive" by B. J. Vierling and Lan H. Caldwell, Capital Airlines, was presented at the SAE National Aeronautic Meeting, Los Angeles, Calif., Oct. 3, 1946.

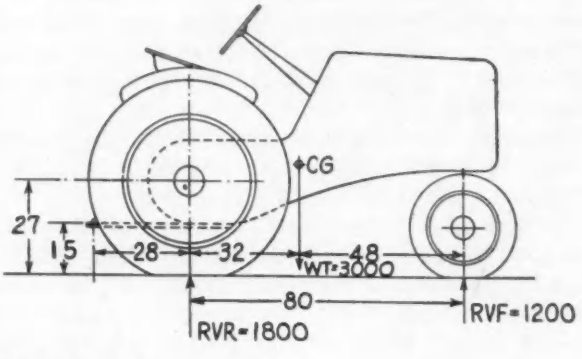
Mating Tractor Design with Implement

■ ASSUMPTIONS

AS the method of analysis is more important than the results, several assumptions have been made to simplify the examples. A common tractor weighing 3000 lb, with dimensions as shown in the illustration, has been used throughout. The center of gravity provides a normal static weight distribution of 60% on the rear wheels and 40% on the front. This tractor is versatile in that its weight is always 3000 lb divided 60/40 regardless of the lifts and hitches needed for different types of mountings.

The implement used is a lister (double plow), with a horizontal draft component of 1500 lb and a vertical component of 20%, or 300 lb, being assumed in all cases. Implement weight is included in the 3000-lb tractor weight. Under these conditions, the implement draft and draft line are constant.

In analyzing the forces and their effect on the



■ FIRST FIGURE

tractor, lesser forces such as rolling and wind resistance have been omitted since they are important only under extreme conditions.

Each analysis attempts to determine soil reaction on the front wheels for steering control and stability, and on the rear wheels for traction. It is assumed that rubber tires are used and that the tractive coefficient is 0.5. All analyses are made with the tractor level.

Symbols used in this discussion are:

W_t = Tractor Weight,

W_i = Implement weight effective during operation

W_l = Load weight,

$C.G.$ = Center of gravity,

R_{sf} = Supporting soil reaction to front wheels

R_{sr} = Supporting soil reaction to rear wheels,

R_{hr} = Tractive soil reaction to rear wheels,

C = Intersection of the resultants of the tractive and supporting soil reactions against the drive wheels,

P = Total load resistance,

P_h = Component of load resistance parallel to the direction motion,

P_v = Component of load resistance perpendicular to the direction of motion.

P_u = Load resistance in upper link,

P_l = Load resistance in lower links,

D = Draft of implement.

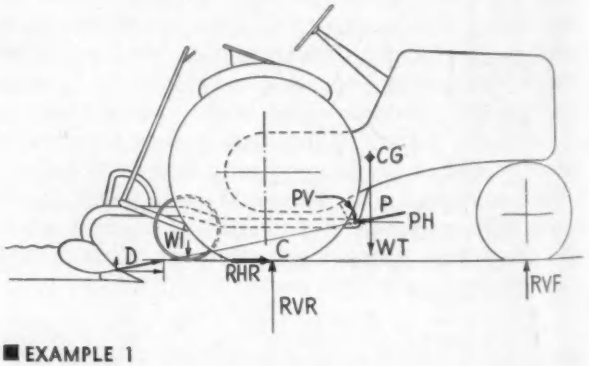
■ PARTIALLY MOUNTED IMPLEMENT WITH GAGE WHEEL

To secure a more maneuverable unit and at the same time reduce headland widths, mounted implements became the vogue with acceptance of high clearance all-purpose tractors. Simplest mounted implement is best described as "partially mounted"; implement draft member is attached under the belly of the tractor and the rear of the frame supported on gage wheels, which govern plowing depth.

For turning and transport, the implement and its gage wheels are lifted clear of the ground.

With proper hitching, gage wheels do little except when passing over rough and uneven terrain. By improper hitching, an abnormal load consuming considerable power may be imposed on the gage wheels. Only remedy is to make better engineers of our farmers.

Effect of this type of mounting on the tractor



■ EXAMPLE 1

Mounting

FROM A PAPER

By D. C. Heitshu*

Commonly used implement mountings and tractor configurations discussed in this article offer the engineer a guide in creating new designs.

The author demonstrates a technique for determining the forces on the tractor resulting from the application of implements.

is determined by resolving the moments about point C. The lister is attached to the tractor 27 in. ahead of the rear axle center line and 12 in. above the ground line. Result is the following equations:

$$R_{vf} = \frac{W_t \times 30}{78} + \frac{P_v \times 25}{78} - \frac{P_h \times 12}{78}$$

$$= 1020 \text{ lb}$$

$$R_{vr} = \frac{W_t \times 48}{78} + \frac{P_v \times 53}{78} + \frac{P_h \times 12}{78}$$

$$= 2280 \text{ lb}$$

$$R_{hr} = R_{vr} \times 0.5$$

$$= 1140 \text{ lb}$$

These figures indicate that the tractor is quite heavy in front and in need of considerable weight in the rear to pull the lister with 1500-lb horizontal resistance. Provided the tractor is stable with the implement in the raised or transport position, the center of gravity should be designed farther to the rear than is indicated in this tractor.

Desirable location of the weight in a tractor cannot be determined until a careful study is made of the various implements intended to work with the tractor.

■ MOUNTED IMPLEMENT WITHOUT GAGE WHEEL

By simply removing the gage wheels and gaging the implement from the tractor, relative performance of the tractor can be improved.

Hitched in this manner, the implement may be gaged by adjusting the hitch or by support from the tractor. A combination of hitch and support for control of the implement is commonly employed.

Main reason for the better tractive condition with this type of attachment is the rearwardly suspended weight of the implement. This weight (W_1) creates a favorable moment about point C that was not achieved in the preceding hitch.

Point C remains 2 in. ahead of the center line of the rear axle. The implement weight, W_i, is centered 23 in. to the rear of the drive axle axis and is assumed to be 250 lb. The hitch location is the same as that used in the preceding example. Again taking moments about point C, the following equations evolve:

$$R_{vf} = \frac{W_t \times 30}{78} + \frac{P_v \times 25}{78} - \frac{W_i \times 25}{78} - \frac{P_h \times 12}{78}$$

$$= 940 \text{ lb}$$

$$R_{vr} = \frac{W_t \times 48}{78} + \frac{P_v \times 53}{78} + \frac{W_i \times 103}{78} + \frac{P_h \times 12}{78}$$

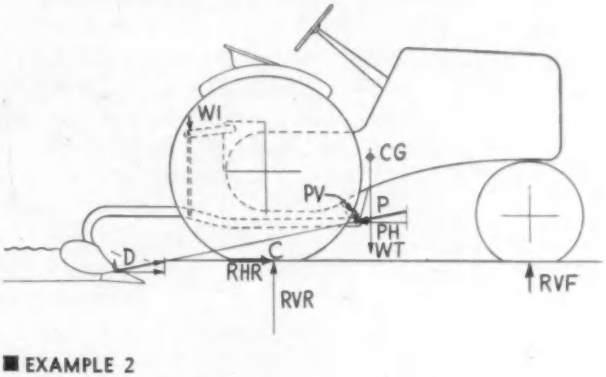
$$= 2610 \text{ lb}$$

$$R_{hr} = R_{vr} \times 0.5$$

$$= 1305 \text{ lb}$$

Comparing the tractor wheel loadings using this type of hitch with the arrangement in Example 1 shows a favorable weight of 330 lb on the drive wheels. In fact, the drive wheel loading is 60 lb higher than with a drawn implement even though the front loading is 190 lb above that experienced with a trailing machine.

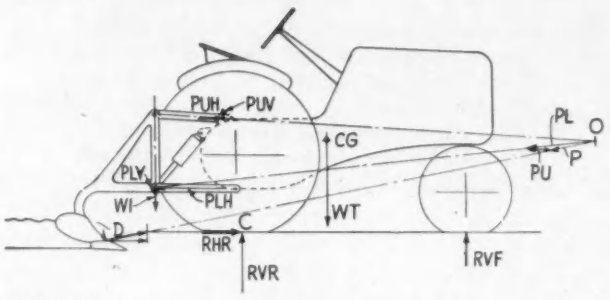
In this case it again appears undesirable to use the 60/40 weight distribution set up for the tractor in this analysis. If the weight distribution of the tractor is not changed, effective weight of the drive wheels can be helped by (1) increasing the implement weight, (2) hitching the implement farther to the rear or higher, or (3) changing the implement to increase the slope of the draft line D, increasing the vertical component of D.



■ EXAMPLE 2

* Paper "Load Reductions, Weight Transfer and Operational Effects Resulting from the Mounting of Implements on Tractors," by D. C. Heitshu, of Harry Ferguson, Inc., was presented at the SAE National Tractor Meeting, Sept. 11, 1946.

■ NONPARALLEL LINKAGE MOUNTING



■ EXAMPLE 3

The nonparallel linkage mounting has received considerable attention in recent years, one reason being that it is a basic part of the Ferguson system on the Ford tractor. Its two outstanding advantages are (1) the ease of attaching to and detaching from the tractor and (2) the advantageous use of the implement's entire weight to load the rear wheels for traction.

As shown in the illustration, the links extend 28 in. to the rear of the drive-wheel center line and support a lister with a 350-lb reaction at that point while operating in soil. The implement is supported and gaged by the lower links.

Resolving P_u and P_l into components parallel and perpendicular to the direction of motion and taking moments about point C, we get the following equations:

$$R_{vf} = \frac{W_i \times 30}{78} + \frac{P_{uh} \times 40}{78} - \frac{(P_{lv} + W_i)\,30}{78} - \frac{P_{lh} \times 15}{78} - \frac{P_{uv} \times 7}{78}$$

$$= 895 \text{ lb}$$

$$R_{vr} = \frac{W_i \times 48}{78} + \frac{(P_{lv} + W_i)\,108}{78} + \frac{P_{lh} \times 15}{78} + \frac{P_{uv} \times 85}{78} - \frac{P_{uh} \times 40}{78}$$

$$= 2755 \text{ lb}$$

$$R_{hr} = R_{vr} \times 0.5$$

$$= 1377 \text{ lb}$$

Again the front wheels are loaded higher than required for good steering and stability. Although effective weighting of the drive wheels is higher than for the previous hitches, the tractor rear wheels require additional weight to produce the needed 1500-lb drawbar pull.

■ FORWARD MOUNTED LOADER

With the front end loader shown, in which there is great interest, three conditions must be studied, namely: (1) loading, in which the loader is pushed into the material and lifted; (2) static condition with load; and (3) backing with load.

Both load and resistance to load are taken as 1000 lb. Center of the load is assumed to be 40 in. ahead of the front-wheel center line. As conditions change from loading to static to backing, point C is assumed to vary from 2 in. ahead of center, to center, to 2 in. back of center. For backing, a tractive effort of 500 lb at a 15-in. height is assumed.

Resolving the forces as moments about point C, C′, and C″, the following equations develop:

Loading

$$R_{vf} = \frac{W_i \times 30}{78} + \frac{W_i \times 118}{78} - \frac{P \times 15}{78}$$

$$= 2475 \text{ lb}$$

$$R_{vr} = \frac{W_i \times 48}{78} - \frac{W_i \times 40}{78} + \frac{P \times 15}{78}$$

$$= 1525 \text{ lb}$$

$$R_{hr} = R_{vr} \times 0.5$$

$$= 762 \text{ lb}$$

Static

$$R'_{vf} = \frac{W_i \times 32}{80} + \frac{W_i \times 120}{80}$$

$$= 2700 \text{ lb}$$

$$R'_{vr} = \frac{W_i \times 48}{80} - \frac{W_i \times 40}{80}$$

$$= 1300 \text{ lb}$$

Backing

$$R''_{vf} = \frac{W_i \times 34}{82} + \frac{W_i \times 122}{82} + \frac{P \times 15}{82}$$

$$= 2820 \text{ lb}$$

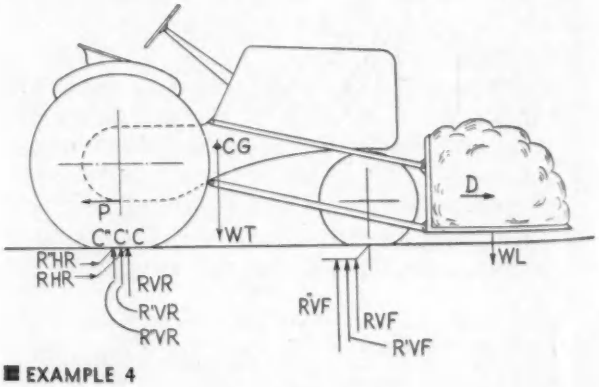
$$R''_{vr} = \frac{W_i \times 48}{82} - \frac{W_i \times 40}{82} - \frac{P \times 15}{82}$$

$$= 1180 \text{ lb}$$

$$R''_{hr} = R_{vr} \times 0.5$$

$$= 590 \text{ lb}$$

The entire front end of this tractor must be redesigned to handle loads imposed by the front end loader. Also weight must be added to the rear tires to get required traction.



■ EXAMPLE 4

Management Control Through Industrial Engineering

EXCERPTS OF A PAPER BY **E. F. Gibian***

MANY new industrial engineering concepts have been devised and applied in recent years, emphasizing the rôle of engineers, and engineering thinking and methods to management's task of controlling finance, sales, engineering, human relations, and manufacturing.

Organization of an industrial engineering division within a company will vary with the needs, structure, and size of the enterprise. The industrial engineering program of a larger company, composed of several plants or divisions, is planned and directed by a chief industrial engineer. The staff, a comparatively small group of specialists, is shown in the organization chart, Fig. 1. The department sets standards, evaluates jobs, sets up budgetary controls of all plant operations, lays out plants, improves methods, and effects simplification. A divisional department is shown in Fig. 2.

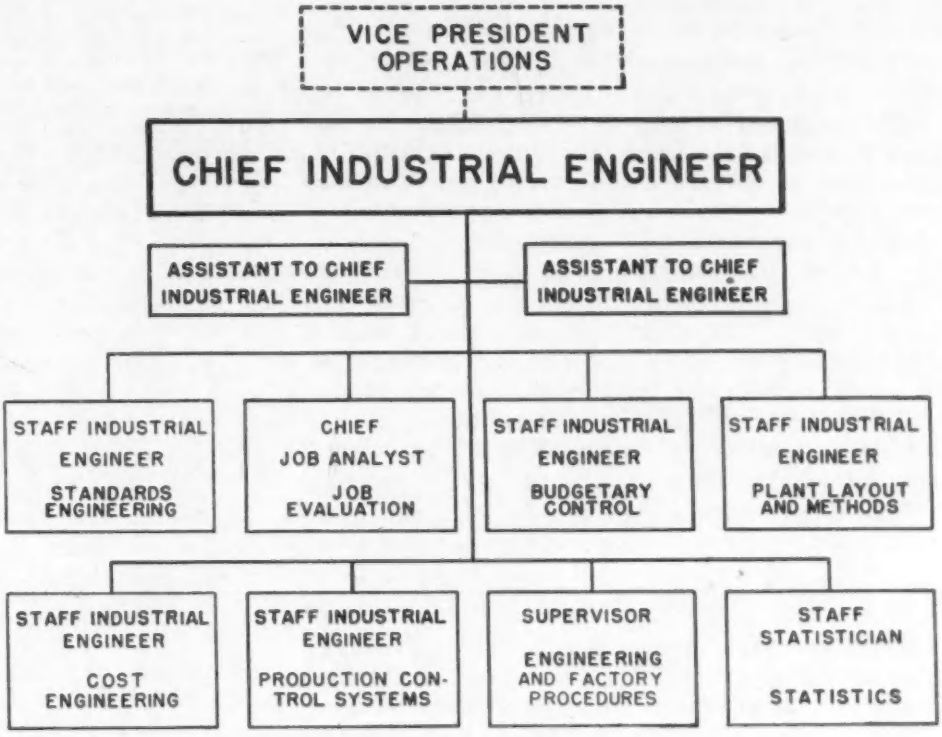

VICE PRESIDENT OPERATIONS
CHIEF INDUSTRIAL ENGINEER
ASSISTANT TO CHIEF INDUSTRIAL ENGINEER
ASSISTANT TO CHIEF INDUSTRIAL ENGINEER
STAFF INDUSTRIAL ENGINEER STANDARDS ENGINEERING
CHIEF JOB ANALYST JOB EVALUATION
STAFF INDUSTRIAL ENGINEER BUDGETARY CONTROL
STAFF INDUSTRIAL ENGINEER PLANT LAYOUT AND METHODS
STAFF INDUSTRIAL ENGINEER COST ENGINEERING
STAFF INDUSTRIAL ENGINEER PRODUCTION CONTROL SYSTEMS
SUPERVISOR ENGINEERING AND FACTORY PROCEDURES
STAFF STATISTICIAN STATISTICS

Fig. 1 – Organization and Functional Chart of a Staff Industrial Engineering Department

Because all these activities have a close tie-in with industrial accounting, a cost engineer serves as cost analyst and is the liaison man to keep accounting and industrial engineering in step. A specialist on production control assists divisions in control procedures.

Engineering and factory standard practice instructions also fall under the chief industrial engineer, and are prepared and published by the supervisor of this division.

Scientific analysis of data on manpower, wages, performance figures, and proper presentation of conclusions to higher management levels require the services of a statistician, who is also charged with certain control methods based on the science of statistics.

Prime objectives of the staff industrial engineering department are budgetary control and methods improvement.

Direct labor standards and time study measures a fair day's work. In a budgetary control program, where correct labor standards are of paramount

* Paper entitled "Management Control through Industrial Engineering," by E. F. Gibian, chief industrial engineer, Thompson Products, Inc., was presented at SAE National Production Meeting, Cleveland on Oct 14, 1946.

importance, a clear definition of a standard is needed. "Average times" is meaningless. The amount of work that has been done is unimportant. The amount of work that *should* be done is the basis of a standard.

The standard for operating labor should be defined as the maximum rate of output at required quality which a skilled worker, given adequate rest, satisfactory supervision, good methods and equipment, and a continuous supply of raw materials and tools, can maintain through the regular working hours, day after day, without injury to his health.

Experience in the use of this basic or budget standard, which satisfies the level of 100% at "high task," has demonstrated numerous advantages over the conventional practice. It is a more usable and accurate yardstick.

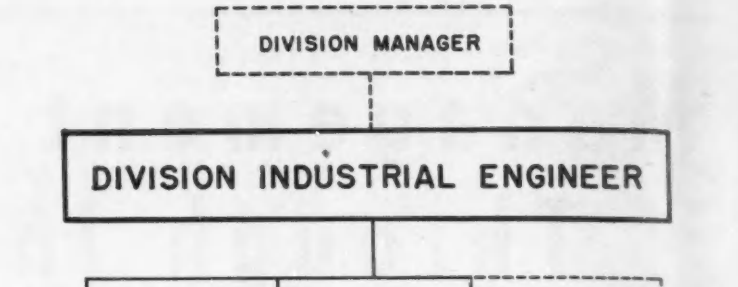


Fig. 2 – Organization Chart of a Division Industrial Engineering Department

The fundamental concept of a standard implies that it should be related to definite methods and conditions of manufacture. True values of standards can be maintained only if they are promptly revised whenever there is a measurable change in the method and conditions surrounding the job.

Hence it is important to record in detail the set-up, method, and conditions under which a standard has been established. Such details as type of machine, material, tools, jigs, fixtures, speeds and feeds, amount of material removed, cutting lubricant, tolerances, and quality requirements should all be recorded.

This is done with an operation sketch and a related time study sheet for each given operation.

Machine Standards

Machine standards are usually stated in terms of standard machine hours, and give the number of machine hours which should have been used to produce a given quantity of pieces. To a large extent these standards are determined from time studies taken to establish labor standards and consist of:

a. Standard machine operating time (regardless of the number of operators servicing the machine) at proper feeds and speeds, with proper tooling to produce the part at the required quality.

b. Standard time required for set-up determined by an engineering study for each type.

c. Standard time required for changing tools, tool grinding, tool troubles, etc., based on an engineering allowance for normal expectancy of such delays, and

d. Standard allowance for delays determined as a necessary part of the operating conditions.

Setting direct materials standards is not necessarily a function of industrial engineering as such standards frequently are more advantageously set by planning engineers.

Expense standards embrace all items of manufacturing costs other than labor, and are expressed in money. This is the responsibility of industrial engineers.

The minimum amount of pieces spoiled per number of pieces produced is determined by engineering studies and is established as a scrap standard.

A complete job analysis and job evaluation sets a proper pay rate for every factory job within the personnel department's general pay scale. The chief job analyst must maintain a balanced wage structure for the entire organization.

A process routing form is recommended for entering these data. It shows the type and size of material, and weight per 100 pieces. The base rate established by the job evaluation for each operation is shown in code.

Standards for labor and machine, expressed in hours per 100 pieces at 100% performance, are entered in two adjacent columns of the form. Standard manhours and machine hours for any required set-up are listed in the last two columns. Another column lists minimum pieces per machine hour which is useful to supervisors and operators.

In a variable budget, standards are predetermined for any level of activity by dividing the budget standards, where applicable, into their fixed and variable components. Its primary object is operating control; its secondary use is for forecasting.

Operating departments should be controlled on a daily basis by a departmental budget report. Labor and machine performance can be reported on a daily basis, but other items can be reported less frequently.

Initially, historical background of a department's operation is used to develop budget stand-

ards for non-productive labor expenses. These should be considered rough or preliminary standards. Inspection, supervision, and general labor are covered in indirect labor data.

Check Standards in Trial Budget

At this stage a trial budget report should be made up for several consecutive days, in which the selected standards will be applied to the current operations of the department under study. The controls engineer will then test the several standards he had selected to determine their validity and fairness. He then issues a tabulation of all departmental budget standards on a budget sheet.

Thus data on machine performance, machine hours, labor, expense, and scrap data are grouped in the budget report. Utilization of the department's machining facilities on a particular day, and cumulatively since the first of the month, can be appraised at a glance.

The relation between standard machine hours to potential is significant to management because it shows to what extent equipment is being used, how the machinery is balanced, how many unused machine hours are available for increasing production, and whether the flow of work has been properly scheduled.

The ratio of standard machine hours to actual is especially significant to foremen because this is a measure of his ability to get the most out of machines.

Day-to-day watching of these data leads to surprisingly good results, and frequently initiates major improvements in methods resulting in gratifying cost reductions.

Because interim standards, derived from historical studies, must be replaced as promptly as possible by carefully engineered standards and adjustments must be made promptly, the control engineer's work is never ended.

The next step calls for monthly summary reports, in which machine, labor, expense, and scrap data are totaled up to show the overall performance of the whole division or plant.

The final step involves the conversion of these monthly summaries into money reports so that management may appraise the significance of budget performance and its effect on the company's profit and loss statement. When this stage is reached, the variable budget program has laid a firm foundation for correlating the budget procedures with an existing standard cost system.

Indirect labor or service labor, and office departments must be included in a complete program, but budget control of these departments usually is undertaken after the budgets of operating divisions have been established.

An intelligently organized budgetary control program is one of the best means for lifting the status of the foreman from a mere boss to the role of a responsible department manager. Hence an important part of the plan is a schedule of short, regular meetings called by the factory manager attended by all foremen and superintendents. At these weekly sessions performance against budget of each department is reviewed, causes of variances are analyzed, and assignments for corrective steps are given. Members of the industrial engineering staff should be on hand.

The program has an effective vertical use in establishing a foundation for the plant or corporation's overall operation. It also has a horizontal use in that its study will help methods engineers to determine where procedures should be simplified. The production control department is guided in scheduling machine loading by the performance level and the trends indicated in the budget reports.

Improvement and simplification of manufacturing methods and equipment, layout in plant, materials handling, and conveying is the long range objective of a company's industrial engineering program. The industrial engineer takes on where the production engineer leaves off.

It is recommended that members of the industrial engineering staff take an active part in training supervisors in such subjects as time study, budgetary control, use of standard practice instructions, simplification of methods, and statistical process control.

Wage Incentives Not Cure-all

Wage incentives have been mistakenly publicized as a major part of industrial engineering. The ultimate in efficiency may not be reached without an incentive pay system, but incentives should not be considered a cure-all or substitute for good management and sound management control.

An incentive plan gives the workman the opportunity to increase his wages for increased effort. To justly compensate for additional output, management and workers must be assured that these conditions exist in a plant:

a. A reasonably steady flow of material must be assured.

b. Sound engineering standards have been developed as yardsticks.

c. Sound methods of measuring performance have been developed, and

d. The plant is staffed with a competent and well trained supervisory organization.

Unless this foundation has been laid, any incentive plan will fall short of its goal. To be successful, an incentive plan must have the workers' acceptance, must be easily understood by them, and the incentive pay must bear a direct relation to the individual's additional effort.

Car Heating Pattern Set by Plane

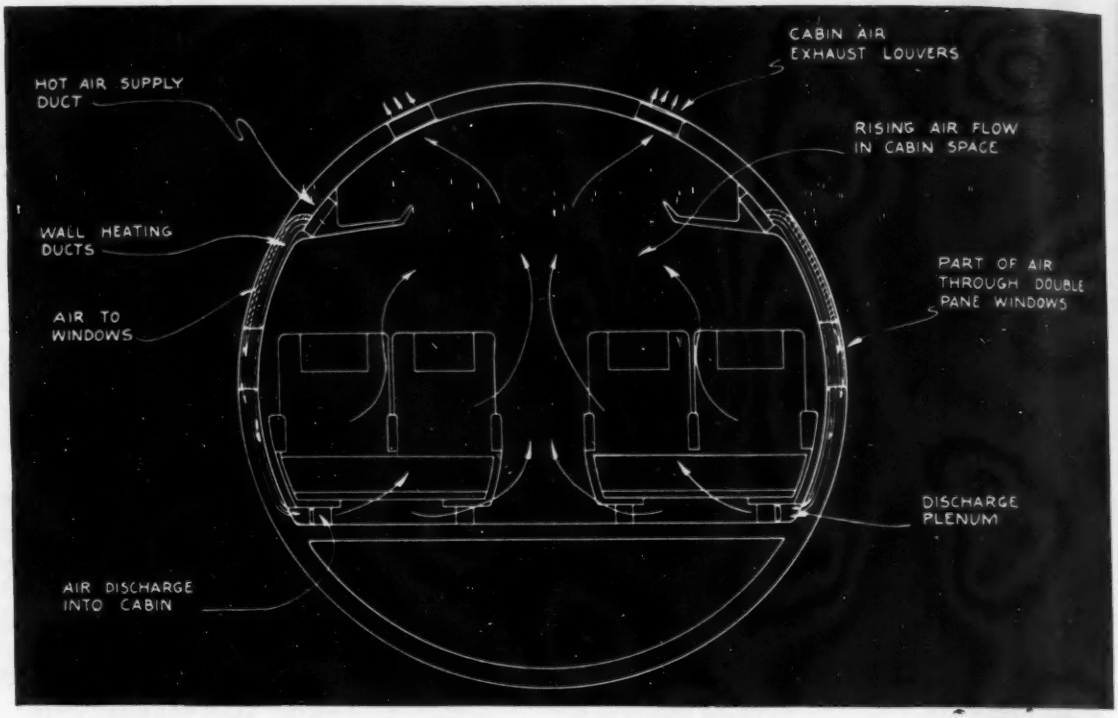

CABIN AIR EXHAUST LOUVERS
HOT AIR SUPPLY DUCT
RISING AIR FLOW IN CABIN SPACE
WALL HEATING DUCTS
PART OF AIR THROUGH DOUBLE PANE WINDOWS
AIR TO WINDOWS
DISCHARGE PLENUM
AIR DISCHARGE INTO CABIN

Fig. 1 (above) – This advanced type of aircraft heating system offers many features worthy of duplication in passenger car heating

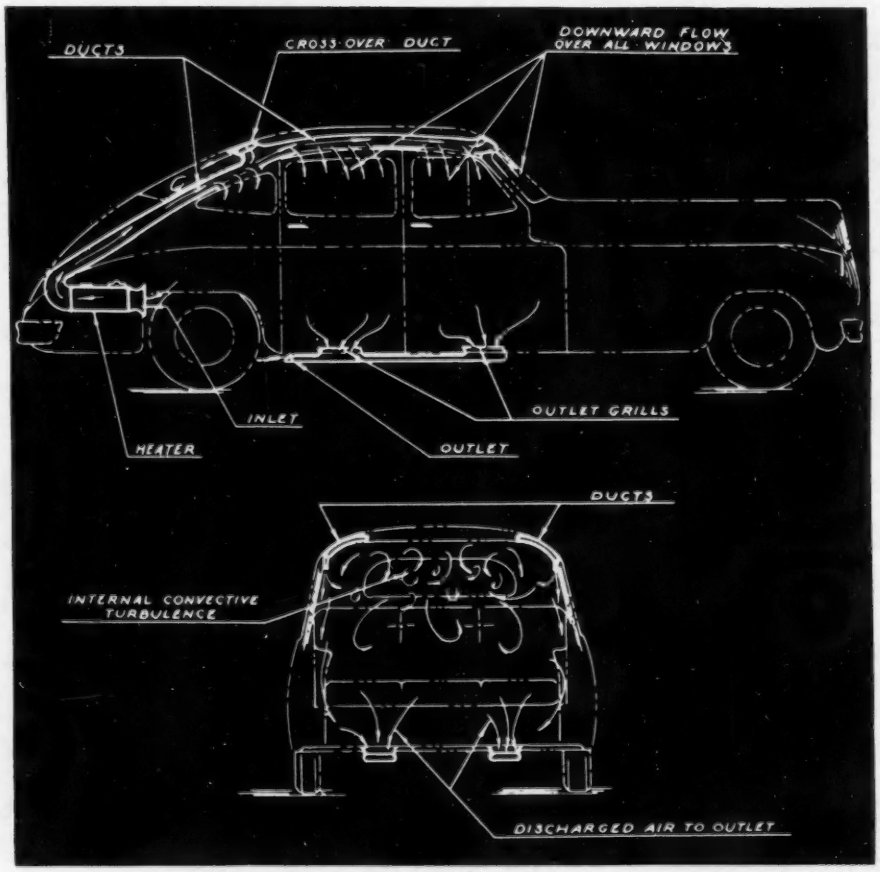


Fig. 2 (below) – Heating future automobiles in this fashion will provide passengers with the same high degree of comfort achieved in modern air transport.

Digest of papers

By L. A. RODERT

National Advisory Committee for Aeronautics

ECONOMY and performance of air transport heating trends are down-to-earth factors worthy of the passenger car designer's consideration, says Rodert. He contends that:

Airplane heating – a compromise between draft reduction, odor suppression, and fog prevention – is well within the range of practicability for automobiles. Both vehicles carry their passengers in about the same cabin space and, whether in the air or on the ground, the passenger requires the same kind of comfort.

How these requirements are being achieved in one new type of airplane is shown in Fig. 1. In this system the designer is attempting to keep the thermal exchange between the wall and occupants to a minimum. He provides each passenger with about 28 cfm of fresh air per passenger and 45 cu ft of cabin space. About 65% of the air is passed through a double wall and window arrangement.

Heated air enters the cabin from supply ducts at the floor level on both sides of the fuselage. All circulated air rises in the cabin from the air inlets to the exhaust louvers at the top and rear of the cabin. A large number

System

of air outlets avoids high local velocities and a feeling of draftiness.

Passenger cabin windows are kept free of fog by the passage of heated fresh air between two glass panes that form the window panels. Ice prevention on the outside as well as fog prevention on the inside of the pilot's windshield are accomplished in the same fashion.

Application of this type of thinking to the passenger car can result in the type of heating system shown in Fig. 2. In this arrangement a heater is mounted in the rear.

Air circulation within this automobile will maintain a high relative humidity – a desirable feature. But since the central interior region is not part of the moving stream, odor intensity will probably be high unless the ventilating rate is high. This undesirable characteristic might be overcome by discharging part of the air across the interior of the top, giving a positive downward airflow over the occupants.

This system will provide uniform warmth and humidity control, while preventing precipitation and keeping foreign matter to a minimum. Power requirements for a ventilating air rate of about 120 cfm through this system are well within the capacity of existing electrical systems. (Paper entitled "Fresh Air Automotive Heating: Influence of Aviation Industry," was presented at SAE National Transportation & Maintenance Meeting, Oct. 16, 1946. The paper "Heating and Ventilation Design Factors in Automobiles," was presented at the SAE Annual Meeting, Jan. 8, 1947.)

Low Tension Whips Plane Ignition Woes

Digest of paper

By J. K. RUDD

Wright Aeronautical Corp.

ANSWER to reliable ignition performance during bad weather and high altitude flights with a minimum of maintenance trouble lies in a low-tension system, Rudd believes. He supports this claim by showing that:

Low-tension ignition exhibits none of the operating malfunctions inherent in high-tension systems and also requires less attention and replacement of individual units.

For example, spark-plug gap erosion rate is one-half to one-third that with conventional ignition. One cause for plug erosion is the capacitance of the ignition system; the higher the capacitance, the greater the erosion. Low-tension ignition has one tenth the capacitance of high-tension systems. As would be expected, testing both systems on a modern engine showed spark-plug life in the low-tension system to be more than doubled.

Resistance to plug fouling also is improved. Fouling is actually a shunt resistance formed across the spark-plug insulation; the more severe the fouling, the lower the shunt resistance will be. Low-tension systems will fire a spark plug with a shunt resistance as low as 0.2 megohm; but with high tension, the plug will misfire with a shunt resistance of about 0.4 megohm.

How resistant this system is to moisture is demonstrated by the test set-up in Fig. 1. A magneto and nine individual transformer coils were suspended in beakers with all low-tension connections exposed. The beakers were filled with tap water and the magneto operated by a belt drive. Even though the breakers and all primary connections were submerged, regular sparking occurred at all gaps.

High-altitude performance of low-tension ignition is remarkably good. During 528 hr of tests under a simulated altitude of 60,000 ft the system did not malfunction. Particular attention was paid to wear of carburetor distributor brushes and the bronze segments on which they ride, arcing of the brushes, and arcing of breakers at high altitude. No abnormal results were observed.

Even subjecting the system to a warm and humid atmosphere for some time before taking it up to a simulated altitude of 50,000 ft did not harm the system or cause misfiring.

Pilots will welcome low-tension ignition because it produces much less radio interference than does high tension. Reason for this is the minimum number of parting parts in the magneto and distributor housing and the lack of a high-tension spark.

Still another advantage of this recent ignition system is easier starting. The booster spark can be timed to occur at optimum position without limitation by flashover in the distributor. Control and firing of the booster circuit does not interfere with basic engine timing used during running.

Contributing to longer life of parts in the low-tension system are the less severe electrical stresses. Secondary winding of the high-tension coil is divorced from the magneto and relocated as close as possible to the spark plug. Thus the magneto generates and distributes relatively low voltage – about 350 v peak – to the proper cylinders and reduces electrical stress in the wiring to a minimum.

Low-tension design facilitates installation and maintenance. All parts are as accessible as possible. The many disconnects in the ignition system itself simplify installation of the system on the engine and replacement of worn or damaged parts.

Flight tests in several military airplanes equipped with low-tension ignition confirmed predicted performance reliability of the system. (Paper entitled "Low Tension Ignition – A System of Merit," presented at the SAE National Aeronautic Meeting, Oct. 4, 1946.)

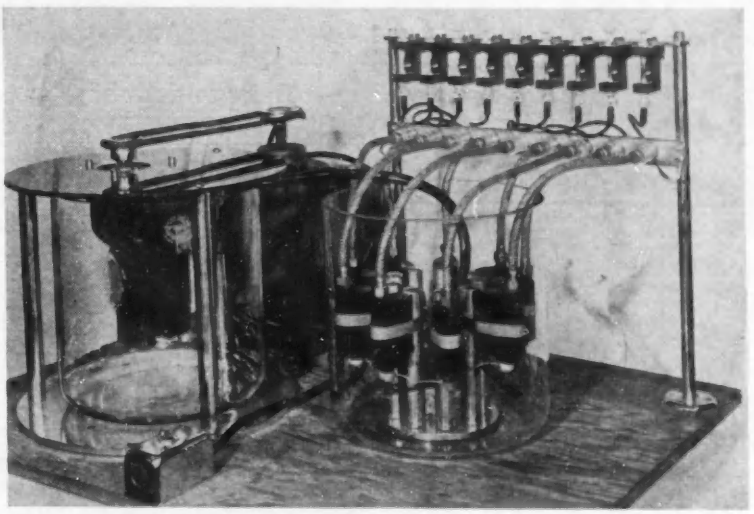


Fig. 1 – Proper sparking with breakers and primary connections submerged in water in this apparatus proved that low-tension ignition systems resist moisture

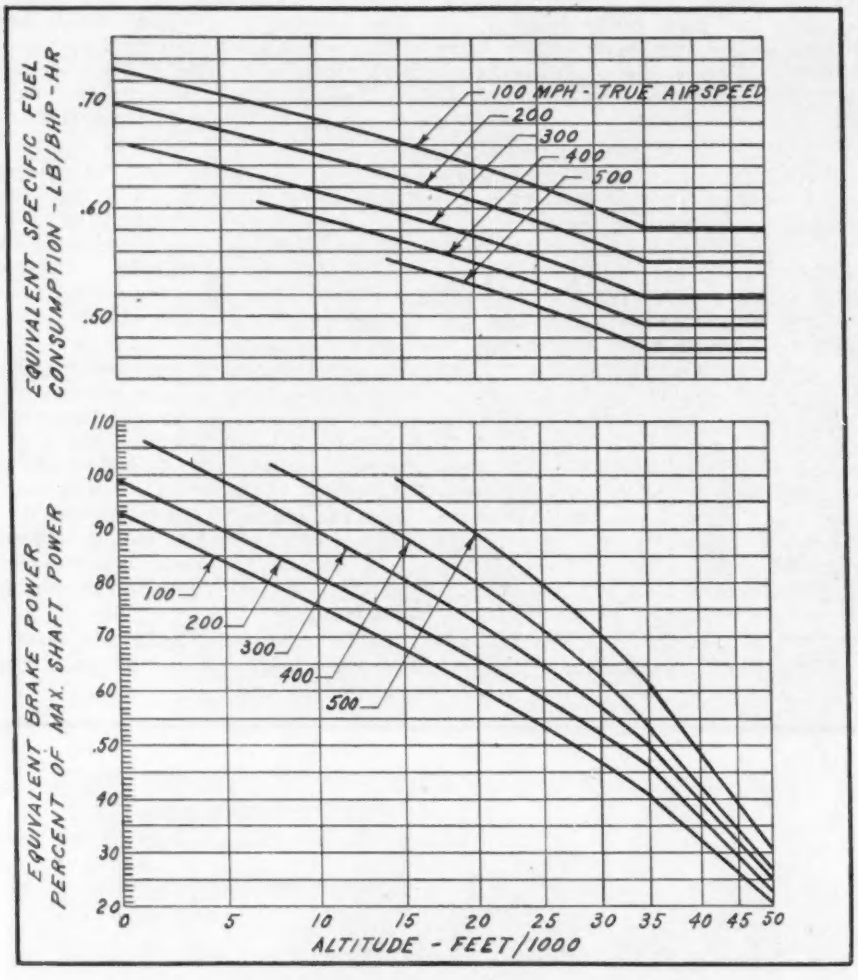


Fig. 1 – Unlike the reciprocating engine, the turbo-prop's fuel economy improves with speed and altitude

Turbo-Prop Air Transport

Digest of paper

By F. W. KOLK

American Airlines, Inc.

ONLY by making possible operations impossible with conventional powerplants or by out-performing reciprocating engines will the turbo-prop engine enjoy widespread air transport use, demonstrates Kolk. Expanding this contention, he points out that:

Inherent characteristics of the turbo-prop adapt this engine to high-speed, high-altitude flight. Most important is the variation of fuel consumption with altitude and speed as shown in Fig. 1. Specific fuel decreases rapidly with speed and altitude, just the opposite of the reciprocating engine's tendency. Proper application of the turbo-prop points to an airframe with extremely low drag with lavish use of power for operation at high altitude and speed.

Present indications are that a conservatively designed turbo-prop operating at 35,000 ft and 450 mph will approach the fuel consumption of a comparable turbosupercharged reciprocating engine.

Another factor in favor of the turbo-prop is ease of maintenance. The parts are relatively few. This is important in the high horsepower engine class since large output piston engines are complicated structures. Rebuilding a conventional powerplant requires many hours of machining to bring the parts within the close tolerances required.

One conceivable niche in the air transport picture the turbo-prop can fill is the North Atlantic transoceanic hop. At present all international flights over this route must refuel at Newfoundland.

If a turbo-prop can be built with sufficient power for such an airplane and at the same time overcome the operator's skepticism, it will be a potent factor in improving international flight service.

Table 1 – Characteristics of a Domestic and Transoceanic Air Transport Powered by Turbo-Prop Engines

Take-off Weight	170,000 lb
Weight Empty	80,000 lb
Wing Span	150 ft
Wing Area	2,000 sq ft
Length	125 ft
Take-off Horsepower/Engine	5,000 bhp
Cruising Speed	450 mph
Cruising Altitude	35,000 ft
Fuel Required (for 4500 air miles)	10,000 gal

Timber Hauling Rough on Trucks

Digest of paper

By J. C. SHEASGREEN

Comox Logging & Railway Co.

TRUCKS for day-to-day logging operations must be built to absorb terrific abuse, reports Sheasgreen. It is his experience that:

Selection of trucks for private road operation leans toward larger custom built models. The big fellows will outperform their smaller brothers under all conditions. But even the strongest truck will break down – especially if misused.

Truck life can be prolonged if vehicle limitations are recognized. No truck will withstand overloading and adverse grades very long without breaking down. Carrying 80 tons on a 40-ton unit is possible; so are long grinds on grades over 5%. But accompanying maintenance cost does not warrant it.

Engines, transmissions, and rear ends heat up and fail if operating limits are exceeded. Overloading damages tires too. Especially is this true in running duals over rough roads where one tire or the other is overloaded.

But the problems balanced against benefits of motorized log hauling are small. Trucking one billion feet of logs in the past ten years proves that any logging operator can successfully use trucks. (Paper "A Logger Looks at Trucks," presented at the SAE National West Coast Transportation and Maintenance Meeting, Aug. 24, 1946.)

Enters Race

Fig. 2 – This is what an airliner fully exploiting the turbo-prop's advantages would look like. This airplane's characteristics are given in Table 1

Investigations also show that an 80-passenger transport powered by four 5000-hp turbo-props will operate economically between Chicago and New York. Cruising at high speeds, such an airplane can attain both economy and traffic appeal in domestic as well as international service. Its general appearance is shown in Fig. 2 and its characteristics in Table 1.

The tremendous reserve of low-altitude take-off power in a turbine designed for high speed and operation is a vital asset. It can make a twin-engine airplane do the job of a four-engine ship. Increasing emphasis on operating economy further accents this feature. Not only will this reduce operating costs, but manufacturing and maintenance expense are bound to decrease.

Success of the turbo-prop's premiere depends largely on two factors: (1) early development of a reliable engine and (2) design of suitable airframe-engine combinations superior to present airplanes. Only the engine manufacturer can solve the first problem. Key to attainment of the second goal is cooperation – cooperation among engine and airplane manufacturers and transport operators. (Paper entitled "The Future of the Gas Turbine in Air Transportation," was presented at the SAE National Aeronautic Meeting, Oct. 3, 1946.)

Human Element Major Cast-Iron Ingredient

Digest of paper

By A. A. WEIDMAN

Detroit Diesel Engine Division, General Motors Corp.

THERE'S NOTHING wrong with cast iron that mutual understanding among the men who make and use it won't cure, declares Weidman. Diagnosing industry's ills, he advises that:

The blame for poor iron castings is shared by all parties involved . . . engineers, purchasing departments, manufacturing departments, inspection groups, and foundries. Each segment of this industry team can improve its operation to result in better iron castings.

The engineer must learn to appreciate cast-iron properties and to design accordingly. Too often he considers only the function of the piece. Cast iron is inherently brittle; obtaining uniform hardness with varying wall thickness is quite difficult; water or oil-tight castings require uniform wall thickness. The trouble with most engineers is that they know so little about foundry practice.

Purchasing departments should be chastised for trying to beat down prices to where foundries are unable to realize a reasonable profit. Not that the sky should be the limit on casting prices; but eyes should be opened to the fact that foundry operating and overhead costs are similar to those of any modern plant.

Manufacturing departments should realize that occasional misruns and minor imperfections happen in the best of foundry families. Instead of crying on somebody's shoulder about their inability to go ahead because of bad castings, production people should exercise intelligent judgment in accepting or rejecting castings. Manufacturing operations should be flexible enough to handle castings with minor defects.

A difficulty common to the inspection force and other groups involved is the lack of a common language. Personnel in the foundry and in the plant often do not recognize a casting defect under one name as being the same thing. Cold shuts, cracks, porosity and blow holes describe different things to different people. A uniform nomenclature as part of a standard foundry practice might well be undertaken by SAE.

Trouble with foundries is that they are bad places to work in. Generally they are dirty and unsanitary. This atmosphere is reflected in both the foundry worker's attitude and output. Another bone buyers have to pick with foundries is that they are not alert to the need for controlling their product's quality and the content of the iron they pour.

If each of these groups learn to carry better its share of the burden and to appreciate the next man's problems, savings to industry will total millions of dollars. (Paper entitled "What's the Matter with Cast Iron?" was presented at the SAE National Production Meeting, Oct. 14, 1946.)

Shop Care Lights Way To Generator Longevity

Digest of paper

By A. M. BAUMP

A. M. Baump Co.

PROPER maintenance and servicing of vehicle generators is recommended to fleet operators by Baump as a means of keeping the cost per ampere to a minimum. Highlighting important maintenance points, he discloses that:

Commutators to be turned should be mounted in a lathe on shaft bearing

Journal Index Available

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surfaces – not on shaft centers. Centers are provided for turning the shaft only. The commutator should be turned at about 700 rpm with a sharp tool set exactly on center so that a smooth surface can be produced with little sandpapering.

When sandpapering the commutator, a strip of 00 sandpaper about 6 in. long should be held at the ends, letting the part of the sandpaper rubbing on the commutator conform to the surface. Holding the sandpaper directly against the commutator with the fingers is not good practice.

After turning, concentricity can be checked with a dial gage attached to the lathe tool post. It should be accurate within 0.0003 in.

Brush spring tension should be measured with a good spring scale and adjusted to the generator manufacturer's specifications. If minimum and maximum pressures are given, always adjust to the maximum pressure; as long as the brushes wear, any reduction of pressure will stay within limits for a long time.

In testing a generator for trouble, it should never be run at more than twice the normal voltage. Generator voltage can rise to 50 or 60 v without any connected load. Without a fuse in the field circuit, this high voltage increases the current flowing in the field coils far beyond their design limit and burns them out in a short time.

Another unit requiring special care is the voltage regulator. Some pertinent do's and don'ts in regulator calibration are:

1. Never change the regulator calibration until you know the condition of the battery and wiring;

2. Never calibrate a regulator cold; always warm it up for about 15 min at half capacity;

3. Never take your final reading with the cover off;

4. Always calibrate a regulator in the normal operating position;

5. Never interchange regulators unless you are sure of staying within the regulator limits.

Final word of advice for freedom from generator woes is to keep the generator free from oil and as cool as possible. (Paper entitled "Fundamentals of Generators and Generator Control Devices," presented at the SAE Spokane Group, Sept. 6, 1946.)

Two-Way Tractor Key To Flexible Farming

Digest of paper

By A. W. TURNER

U. S. Department of Agriculture

DEVELOPMENT of a successful tractor which will go both backward and forward will revolutionize farming by giving it flexibility it now lacks, argues Turner. It is his contention that:

Practicability of the two-way tractor is best proved by examining the job to be done on soil and crops, forgetting about present-day models. Suppose we base our study on some 25 machines and implements commonly mounted on tractors, listed in Table 1.

Location of the machine on the tractor with relation to the operator is an important consideration. In one operation it may be more convenient for the operator to be at the front end of the machine to see the crop and the land ahead of him. Or it may be necessary for him to observe the machine itself in operation. Moldboard plows, for example, if mounted ahead, would dip up and down with the tractor, accentuating ridges and depressions in the field. It would function best if attached midway on the tractor. Best location for other machines is shown in Table 1.

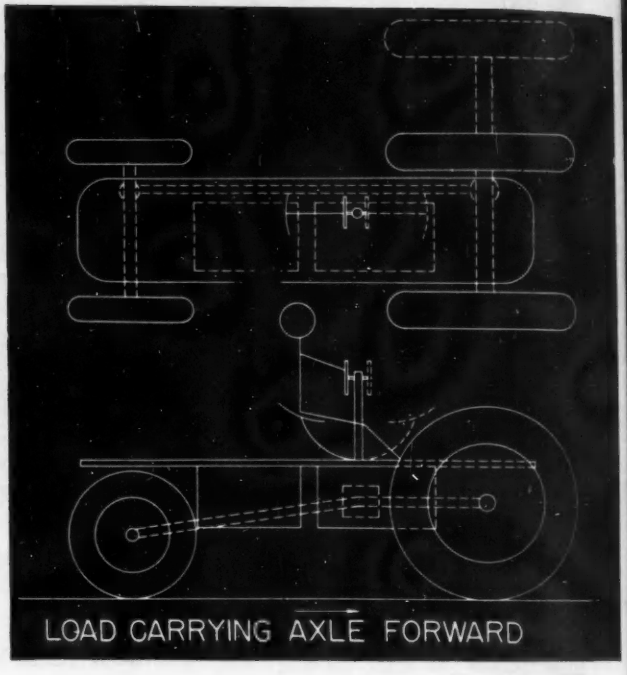

Fig. 1 – This type of operator seating arrangement is suitable for two-way tractors

Table 1 – Location of Machines on Tractor for Best Performance

Machine	Location on Tractor		
	Ahead	Center	Behind
Moldboard plow	...	x	...
Middle buster	...	x	...
Disk plow	...	x	...
Disk harrow	...	...	x
Spike-tooth harrow	...	...	x
Field cultivator	...	...	x
Rotary hoe	...	...	x
Grain drill	...	...	x
*Two-row cotton planter	x	...	...
*Potato planter	x	...	...
*Transplanter[1]	x	x	...
*Row-crop cultivator	x	...	...
*Mower	x	...	...
*Side-delivery rake	x	...	...
*Sweep rake	x	...	...
Loader	...	...	x
*Pick-up baler[1]	x	x	...
*Four-foot combine	x	...	...
*Green-crop harvester	x	...	...
*Two-row corn picker	x	...	...
*Corn ensilage harvester	x	...	...
*Potato digger	x	...	x
*Manure spreader	...	...	x
*Manure loader	x	...	...
Field and market bodies	...	...	x
Total	14	5	8

[1] Operation of the machine is such that some parts operate best in front of the tractor, while other parts function best in another position.

* These machines operate best with the load-carrying axle going forward.

Running down our list of 25 machines indicates that the number of hours in the field with machines attached in front about equals the length of time with machines located at the rear. This fact alone demonstrates the job two-way tractors can perform.

Table 1 also shows that 14 of these machines function best with the load-carrying axle going forward.

Location of the operator depends on a number of factors. He must see the field and performance of his machines. With a tractor operating in either direction, center of the tractor would be the best spot. Such an arrangement is illustrated in Fig. 1. It leaves space over and near the axle for mounting large implements and retains stability in the tractor itself.

Why is the two-way tractor not now available if it can be such a boon to the farmer? There are several reasons

First, we are presently designing tractors to operate horse-drawn equipment.

Second, tractors reflect automobile design. Fuel tanks and engines obstruct the operator's view and force him to assume an awkward sitting position to watch the operation. Third factor is cost. Designers fail to realize that additional expense for transmission gearing and controls can be more than paid for by increased utility of the two-way tractor.

The ultimate all-purpose farm tractor will embody forward and reverse travel. (Paper entitled "Tractors with Facilities for Equal Forward and Reverse Operation; and Their Possibilities for Increased Adaptability for Farm Work," presented at SAE National Tractor Meeting, Nov. 11, 1946.)

Add Function to Art In Vehicle Design

Digest of paper

By R. E. BINGMAN

Industrial Designer

SCIENCE and logic have replaced the inspirational airbrush in vehicle design, relates Bingman. He demonstrates that:

Art for art's sake alone no longer suffices. The designer is a vital link between the factory and market. Unless he combines looks with utility to produce a saleable product, he is useless in modern technology.

Industrial designers recognize this as their raison d'être. No longer will automobile sales people be able to compare new models with a good-looking chorus girl. (Everybody likes her but nobody wants to take her home with him.)

A case in point is the design work on covers for Greyhound buses built by General Motors. Color, texture, and pattern of the seat covering material had to be determined.

Tests disclosed that a short-pile mohair fabric is best for withstanding bus seat wear and tear. In studying stains from tobacco juice, burns, mud, and candy bars, brown was found to be the best color for absorbing these soiling agents. A cue was taken from the frog in developing a suitable camouflaging pattern. Small semi-regular figures are easier on the eyes. By this Sherlock Holmes approach, the fabric almost designed itself.

When the designer and engineer realize each others' problems and potentialities, real progress will be made in mass-produced commodities. (Paper "Design: Accidentally or on Purpose," presented at the SAE Summer Meeting, June 5, 1946.)

High Standards Hold for Plastics in Cars

Digest of paper

By N. J. RAKAS

Chrysler Corp.

ONLY by finding the right plastic for the job will the engineer promote increased use of plastics in the automotive industry, declares Rakas. Describing how Chrysler selects plastics for its cars, he points out that:

Typical of the kind of tests to which a material is subjected before being accepted is the program for testing steering wheel plastics.

In the initial tests, the wheels must not crack at —40F nor soften or deform at 180F. The completely molded wheel is then age-tested through an alternate cycle of heat and cold over a four-day period. During this test the plastic must not crack or check at any point.

Two mechanical tests follow. First is the cantilever test to duplicate the effort exerted on the wheel by the driver in moving in or out of the car. After cooling 12 hr in a cold box at —10F, the wheel is mounted on a test fixture shown in Fig. 1. A 200-lb load is applied downward at right angles to the rim.

Impact tests are important in determining safety characteristics of the wheel. It must withstand impact in an accident without breaking to prevent injury to the driver. Main purpose of the test is to check the weld strength of the steering wheel spider insert. The operation consists of swinging a 100-lb sand bag from a 30-in. height, striking the wheel rim at the spoke intersection. The molded semi-hard rubber or plastic must not splinter or shatter nor the metal welds fail.

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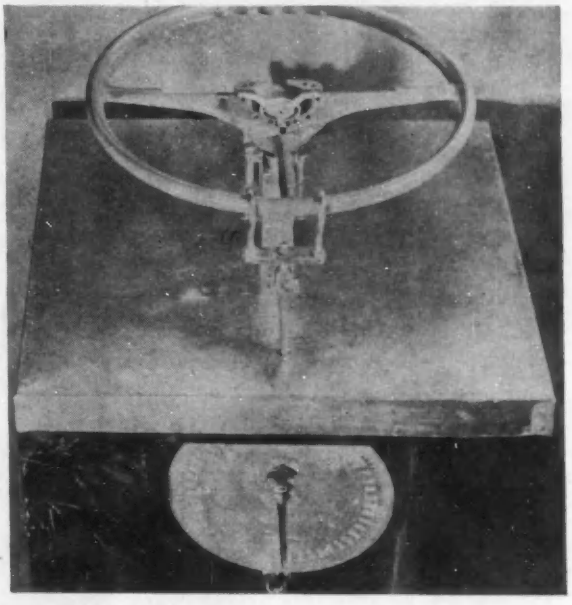

Fig. 1 – Centilever tests on plastic steering wheels simulate forces exerted by the driver

Fig. 2 – Vinylite distributor cap nipples will last as long as the car whereas rubber oxidizes and cracks

Mock-Up Tests Prove Air Conditioning For Planes

DIGEST OF PAPER

By W. W. THAYER

Douglas Aircraft Co., Inc.

GROUND testing the DC-6 air conditioning system for passenger comfort under simulated flight conditions rewarded Douglas with an efficient system at a minimum cost of weight and power, reports Thayer. Describing the test set-up, he points out that:

The test section used was a full scale replica of 30% of the length of the DC-6 passenger cabin. This 15-ft section was placed inside a 6000-cu ft refrigerator, Fig. 1, that alternately served as a hot-box. Cooling – to duplicate ambient temperatures at high altitudes – was accomplished by pumping a solution of dry ice and methanol through four heat exchangers and fan units.

In addition, fans and heaters outside the fuselage section permitted accurate control of fuselage skin temperature within a range of —65F to +120F. Humidity was controllable from 5% to 95%, moisture being subtracted by condensation in an auxiliary cold room, or added by means of an electric steam boiler.

Temperatures and velocities for half the cabin cross-section are shown plotted in Fig. 2. Extreme temperatures ranged from 80F in the light trough to 72F at the floor near the exhaust grill with an outside skin temperature of —40F. Under these conditions, the air temperature entering the cabin was only 80F (less than skin temperature) indicating the high effectiveness of heated floor and side wall panels. Air injected at the inlet slot at 1500 fpm followed the baggage rack contour and diffused out into the cabin. In no cases were there objectionable drafts on the passengers or stagnant pockets where cigarette smoke could collect.

One particular test run more than paid for the entire program. Using typical subjects – men and women of all ages, smokers and nonsmokers – it was determined that recirculated air is not needed in the DC-6, and may even cause adverse effects. Without this test, probable decision would have been to install a recirculation system at

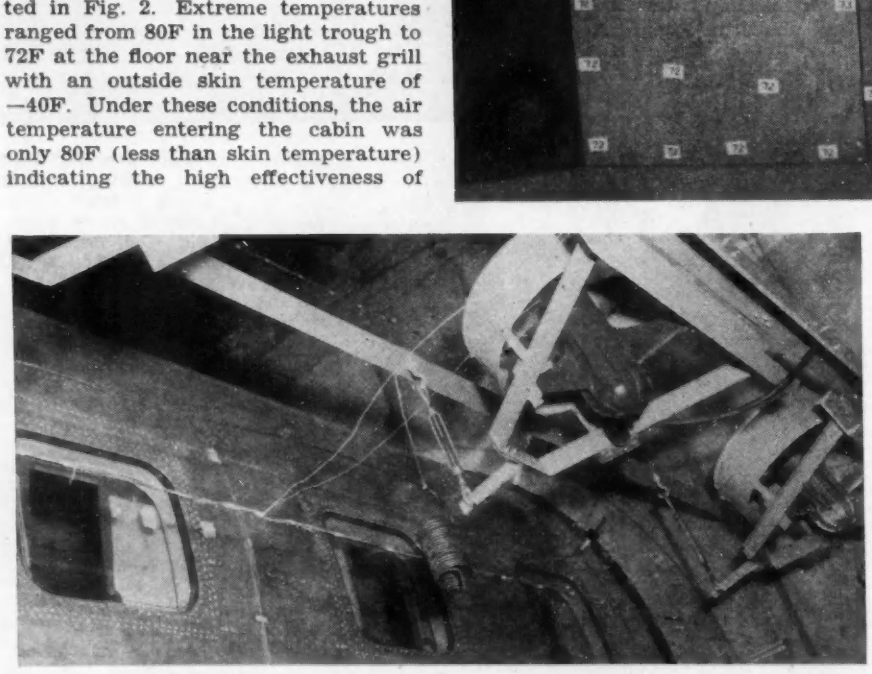

Fig. 1 – Inside a 6000-cu ft refrigerator, the 15-ft length of DC-6 passenger cabin was subjected to subzero exterior temperatures to check effectiveness of interior air conditioning system

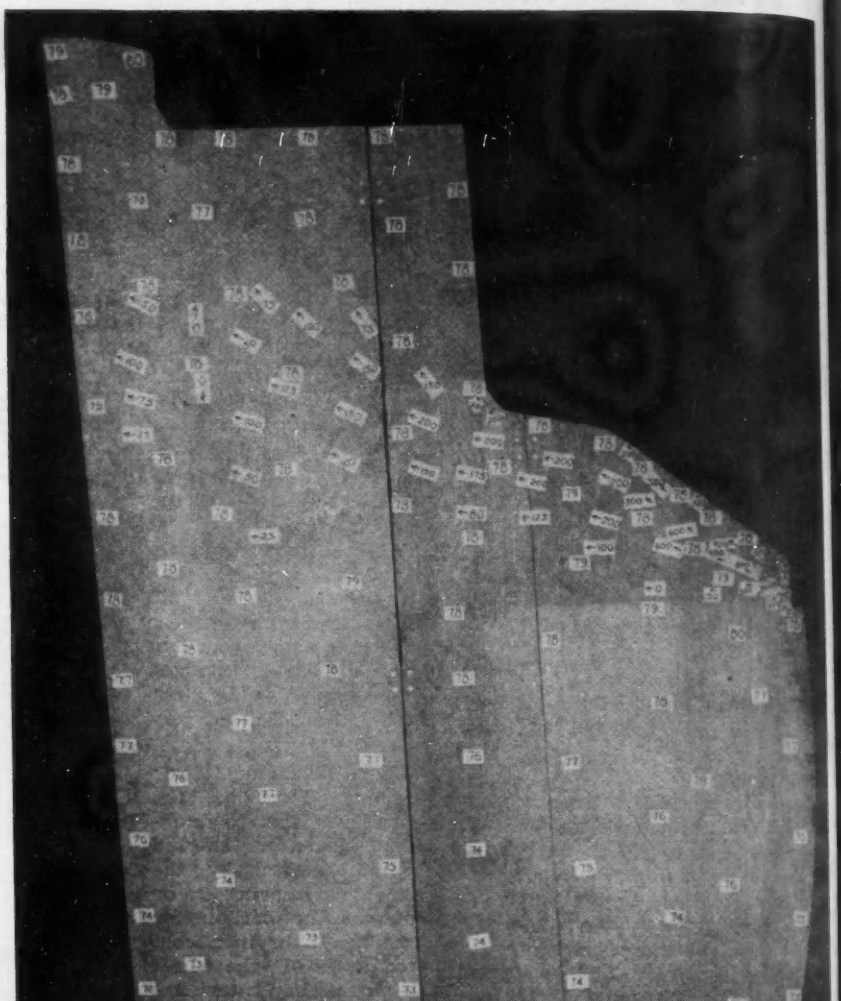

Fig. 2 – Plotting air velocities on this plywood board aided in designing a comfortable air conditioning system

considerable increase in cost, weight, and complexity.

This air conditioning system passed its acid test in a check run with a full load of passengers. Air was introduced into the compartment under exterior conditions simulating a 104F, 30% humidity day. Section temperature gradually levelled out at about 85F after the first hour – about 20F below outside air temperature.

Without taking to the air to find the answers, a hard bargain had been driven with cooling demands since the cooling system cost only 40 lb and 12 hp, in addition to the cabin supercharging system requirements. (Paper entitled "Proof Testing the DC-6 Air Conditioning System for Passenger Comfort," presented at the SAE Southern California Section, May 3, 1946.)

Plastics in Cars

cont. from p. 83

Only three plastics have successfully passed all these tests – cellulose acetate butyrate, ethyl cellulose, and elastromeric polyvinyl chloride acetate. Because cellulose acetate butyrate is cheaper than ethyl cellulose, it is the only material used in fabricating steering wheels. Although nonrigid vinyls are cheaper than either of the cellulose plastics, they show flow lines and have n poor surface gloss.

Plastics are particularly good for instrument dial faces as numbers can be molded deeper in plastics than they can be etched in glass. This provides a three-dimensional effect and facilitates reading. Methyl methacrylate is best suited for this purpose because it has good internal light reflection or edge-lighting characteristics.

Not all plastic applications in a car are decorative or visible to the eye. Flexible vinyls are particularly well-suited for automotive electrical systems. Wiring tape or terminal sleeves made from these vinyls maintain their flexibility for the life of the car. Their resistance to water is high and their insulation characteristics do not change with time. Rubber will eventually be oxidized by ozone near high-voltage ignition wires and crack.

Fig. 2 shows how rubber and vinyl compare when used as ignition distributor cap nipples. By keeping out moisture and dirt during wet weather, vinyl insures starting.

Although plastic car bodies are a long way off, new uses for plastics undoubtedly will be found. Their possibilities are limited only by the imagination of the designer and the skill of the engineer. (Paper "Present Uses of Plastics in the Automobile Industry," was presented by N. J. Rakas at SAE Detroit Section, Oct. 21, 1946. Then with Chrysler Corp., he has since joined Fisher Plastics.)

High Flying Demands Better Electrical Units

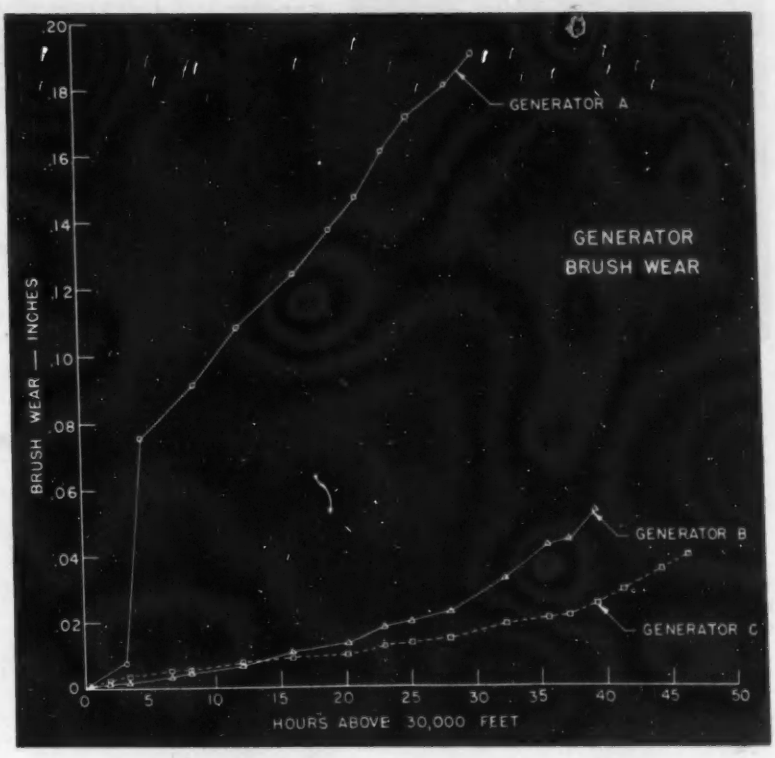

Fig. 1 – High-altitude tests show that metal-graphite brushes (generator A) wear more rapidly than the electro-graphitic type (used in generators B and C), although both types have too short a life

Digest of paper

By H. H. HOWELL

Boeing Aircraft Co.

HIGH-ALTITUDE test flights reveal room for improving aircraft electrical equipment, according to Howell. Reporting test results, he shows that:

These tests were conducted in a four-engine, pressurized cabin airplane and the electrical equipment was subjected to low air density, low temperature, and low water vapor found at high altitudes. Flights were made in ascending and descending levels of 10,000-ft intervals up to 40,000 ft.

Most apparent effect on equipment at high altitudes is the greatly increased brush wear caused by a small amount of water vapor in the air. Unless brushes are specially treated, their life may be dangerously short.

Generator brushes tested did not have sufficient life for use at altitude, although brushes for electric propellers and inverters do exhibit satisfactory life at 40,000 ft. Fig. 1 shows that electrographitic brushes wear better than the metal-graphite type, but both kinds fall short of generator needs.

A group of 28-v d-c intermittent-duty shunt motors rated at 2 hp and 4000 rpm were tested at high altitudes in an ambient temperature of approximately —20 F. One failed; solder was thrown from the commutator. Two closed type 24-v pump motors also failed. In one the brush assembly arced over and, in the other, the bearing liner loosened and jammed the armature.

Two types of AN switches, a push switch, and two types of relays were subjected to the —20 F, 40,000-ft altitude test. Only one push switch failed during the tests while all the other specimens performed well after a series of seven altitude tests. No defects could be found in the design or the spacing of these units.

Disclosures made in these tests show designers how they can increase reliability of modern high-flying high-speed aircraft. (Paper entitled "High Altitude Performance of Aircraft Electrical Equipment," presented at SAE National Aeronautic Meeting, Oct. 4, 1946.)

About

SAE Past-President HARRY T. WOOLSON retired after 25 years of executive engineering duties with Chrysler Corp. He is also president of the Chrysler Institute of Engineering and vice-president of the Marine Division. President of the Society in 1937, he was also active as a member of the Passenger Car Activity Committee, Tire & Rim Division of the Standards Committee, ASA Section Committee, Ordnance Advisory Committee, and served for many years as a Councilor. A dinner, honoring Mr. Woolson, was held at the Detroit Golf Club on January 10.

Formerly with Motor Products Corp., **J. DEAN ELLIS** is now president and consulting engineer for RAD Industries, Inc., Detroit.

Resigning as project engineer of Bendix Aviation Corp., **JOSEPH MARINELLI** has been named director and vice-president in charge of engineering, Consolidated Air Transit, Inc., Teterboro, N. J.

ROBERT W. COLBURN, who was a design engineer with Conkle & Co., is now president and general manager of Airways International Agency, Hialeah, Fla.

Having received his discharge from the U. S. Navy, **EDWARD H. FENN** has become service engineer, Palmer Bros. Engines, Inc., Cos Cob, Conn.

ARMEN A. KASARJIAN is now director of research for A & K Development Co., Elmhurst, L. I., N. Y. He was formerly with Aero Spark Plug Co., Inc., New York City.

JOSEPH A. McCARTNEY resigned from McQuay-Norris Mfg. Co., in order to conduct a business of his own, McCartney Mfg. Co., Joplin, Mo., manufacturer of machine tools.

THOMAS L. HIBBARD has been appointed new director of styling for the Ford Motor Co., Dearborn. Before he was 20, he served as chief designer for the C. P. Kimball Co., Chicago, custom body builders. After leaving Cadillac as chief stylist, he joined Ford as special project engineer.

ADOLF GELPKE, production manager since 1944, was elected a vice-president of the Autocar Co., Ardmore, Pa., at a meeting of the board of directors. Active on numerous SAE technical and administrative committees, he was chairman of the Motor Coach and Motor Truck Division in 1941-42 and served on the SAE Ordnance Advisory Committee.

The Perfex Corp., Milwaukee, leading manufacturers of automatic temperature controls and industrial engine radiators, has announced that president **JULIUS K. LUTHE** was elected to the position of Chairman of the Board of Directors. He founded the corporation in 1934 and has been its president since that date.

DR. SIDNEY M. CADWELL has been appointed director of research and technical development of the U. S. Rubber Co. Formerly assistant general manager of the company's tire division, he brings to his new position 27 years of administrative and scientific experience in the fields of rubber and plastics.

Previously a trainee at Chicago Pneumatic Tool Co., Franklin, Pa., **CHIEH-NGE WEN** is now employed by the Chinese Petroleum Corp., Shanghai, China.

WILLIAM C. MORGAN, JR., formerly with Perfect Circle Corp., is now sales manager of the Original Equipment Division of Walker Mfg. Co., Jackson, Mich.

Having left Hayes Industries, Inc., Jackson, Mich., **HENRY H. KERR** is now in charge of aircraft wheel and brake development engineering for U. S. Rubber Co., Detroit, Mich.

F. S. JONES is now employed by Phelps Dodge Copper Products Corp., research department, Elizabeth, N. J.

Graduating from General Motors Institute, **CLARENCE A. HUNAULT** is now junior mechanical engineer, A. C. Spark Plug Division, GMC, Flint, Mich.

Having recently been discharged from the service, **THOMAS MARTIN** is now affiliated with the engineering department of National Supply Co., Springfield, Ohio.

Formerly general works manager, ACF-Brill Motors Co., Philadelphia, **CARL L. HECKER** is now general manager of the South Bend plant, Oliver Corp.

Metallurgical engineer of the Climax Molybdenum Co., St. Catherines, Ontario, Canada, **THOMAS W. HARDY** was director of metallurgy, Atlas Steels, Ltd.

Now design engineer for Fairchild Camera & Instrument Corp., Jamaica, L. I., N. Y., **ANDRE R. BRAULT** had been with Austin Co. as a mechanical engineer.

JOSEPH E. CARLTON is with the Radio Corp. of America's Harrison, N. J., plant, in the standards department.

J. WESLEY McKERCHER is now superintendent of overhaul for Airwork Corp., Millville, N. J., Municipal Airport. He had been field service representative of Pratt & Whitney Aircraft, East Hartford, Conn.

Having recently resigned as chief inspector of Fletcher Aviation Corp., **J. EARL TOBEY** is inspector for the Los Angeles branch of Chevrolet Motor Division, General Motors Corp.

Members

Until recently superintendent of technical service, Department of Aircraft Production, Sydney, NSW, Australia, **WILLIAM E. BAPTIST** is now chief inspector of Electrolux Pty. Ltd., Melbourne.

LEON A. HEUSS has resigned from the Central Office of Chevrolet Motor Division, General Motors Corp., Detroit, to join the engineering staff of McDonnell Aircraft Corp., Lambert Field, St. Louis.

Resigning from the faculty of the Aero Ground School, Marist College, Atlanta, Ga., **LAWRENCE P. TANGUAY** is a sales representative for Maynard Tire & Auto Parts Co., Decatur, Ga.

A. FREEMAN SANDERS is now managing director of the Freeman Sanders Engineering Co., Ltd., Trembath, Penzance, England. The firm is in the experimental and consulting engineering field.

Having completed his course at Chrysler Institute of Engineering, **WILLIAM P. BALTHROP** is in the corporation's Engineering Division, Highland Park, Mich.

MIGUEL E. GUERMONT has transferred from the Albion Works of Messrs. Fisher & Ludlow, Ltd., to the Sphinx Works, Birmingham, England. He is technical sales and export manager.

Resigning from Pratt & Whitney Aircraft, **WILLIAM FRANK HALE** is a project engineer with the Product Engineering Division of the Bridgeport Brass Co., Bridgeport, Conn.

NORMAN WILLIAM HOPWOOD, JR., a graduate from Ohio State University, is a student engineer with Ford Motor Co., Dearborn, Mich.

Having served as captain in the Army, **JACK C. VANDERFORD** is now owner and manager of Ideal Beach Sales & Service, Syracuse, Ind.

General Development Co., Elkton, Md., has elected **ELGIN L. SHAW** president. He worked on structural problems of the Goodyear Zeppelin. He had been assistant chief engineer of Goodyear Aircraft Co., Akron, and had been aeronautical instructor in that city's municipal university.

SAE MEMBER HONORED

JACK FRYE, president of Transcontinental & Western Air, Inc., received the Medal of Merit, highest civilian award of the United States Government for TWA's contribution to the war effort at a ceremony in Washington on December 21. The Medal was presented by Secretary of War Robert Patterson, left, on authorization of President Truman.

BEAL P. MOORE is with the Fairchild Engine & Airplane Corp., NEPA Division, Oak Ridge, Tenn., having resigned as laboratory test supervisor of Curtiss Propeller Division, Curtiss-Wright Corp. He is a powerplant engineer in his new assignment.

Until recently senior engineer Stevenson & Kellogg, Ltd., Montreal, **HERMANN LIVINGSTON EBERTS** is works manager of Federal Electric Mfg. Co., Ltd., of that city.

WILLIAM E. BURNETT, former Cadillac engineer, has joined Ford Motor Co. as head of the newly organized experimental section of the company's engineering department, **HAROLD T. YOUNGREN**, vice-president and director of engineering, announced. During the African campaign, Burnett served as a GM technical observer for the M-5 light tank, and moved with the U. S. Army to Sicily and Italy. He was recommended for the Medal of Merit by Brig.-Gen. J. W. Coffee.

WILLIAM WADDELL has left Pratt & Whitney Aircraft to join Continental Motors Corp., Detroit.

Since his discharge from the U. S. Army, Transportation Corps, last February, **KENNETH YATES** has owned and operated the Camp Tejon Garage on Highway 99 in California.

Formerly development engineer for Transcontinental & Western Air, Inc., Kansas City, **J. E. FRAZER** is now TWA's resident representative at Glenn L. Martin Co. in Baltimore.

For his work in connection with development of American war standards as a committee member of the ASA, **W. L. BARTH** has been awarded the Association's Certificate.

Having returned from two and one half years in Iran with the U. S. Army, **BRYON ROTHPLETZ** became superintendent of the automotive transportation department, the Atlantic Refining Co., Dallas, Texas.

SAE Fathers and Sons . . . . .

C. E. McTAVISH, Chairman of the Canadian Section and vice-president and general manager of Perfect Circle Co., Ltd., Toronto, joined the SAE 10 years ago. His son, DAN I. McTAVISH, is service engineer, Auto-Electric Service Co., Ltd., of the same city.

Serving part of two consecutive terms as chairman of the Syracuse Section, WALTER W. BURROWS, standing, is now vice-president of Williamsport Paper Box Co., and his father, E. S. BURROWS, is with Eastern Aircraft Division, General Motors Corp.

DON J. STROOP, left, with the Autocar Co. factory branch, New York City, is assistant chairman of the Metropolitan Section's House Committee. His father, DAVID V. STROOP, is an engineer on the staff of the American Petroleum Institute, New York. "Lucky" is a mutual friend.

■

If any SAE reader knows of any SAE Father-and-Son combinations who are both members of the Society, your editors would appreciate hearing from you.

We will write for photographs. Informal pictures of such combinations are preferred to individual formal portraits.

Your cooperation will be deeply appreciated – we don't want to miss any SAE Father and Son grouping.

Formerly chief engineer, Cook Bros., Los Angeles, **E. S. PRICHARD** is now associated with the Tricoach Co., Bellevue, Wash.

CHARLES W. WOOD, who was assistant to the manager, is now building superintendent of Virginia Electric & Power Co., Richmond, Va.

Prior to joining the Western Electric Co., Kearny, N. J., **HAROLD WINSLOW PAINE** was junior engineer, Electric Boat Co., Bayonne.

JACK G. MENCACCY has been appointed head instructor of vocational aeronautics, Modesto High School, Modesto, Calif.

ELMER L. BROWN is now serving Socony-Vacuum Oil Co., Inc., New Haven, Conn., in the capacity of automotive engineer.

After receiving his discharge from the Army, **JOHN F. KLINE** accepted a position with the National Advisory Committee for Aeronautics Laboratory, Cleveland.

A former Navy man, **A. L. MERCER, JR.,** is now district manager for the Chevrolet Motor Co., Cleveland, Ohio.

ENSIGN JOSEPH A. POREMBA is now affiliated with Thompson Products, Inc., Cleveland, Ohio.

JAMES P. McSWEENEY has recently been appointed personnel instructor of Electro-Motive Division of General Motors Corp., La Grange, Ill.

ARTHUR L. RICHARDS, Aveling-Barford, Ltd., has been transferred from Lincolnshire, England to Rio de Janeiro, Brazil.

SIDNEY KAUFMAN, having been released from the AAF, is now chief of administration at the AAF's Institute of Technology located at Wright Field, Dayton, Ohio.

JAMES FRANCIS HOEY, JR., is now connected with B. J. Sturtevant Co., Division of Westinghouse Electric Corp., Washington, D. C., as sales and application engineer.

Retiring December 31, after 46 years in the automotive industry, **E. H. SHEPARD** has been a research engineer for Chevrolet Motor Division since 1931. He was a member of the SAE War Engineering Board and served on CRC. His career began when he became an experimental engineer for Helios Upton Co., Chicago.

KARL H. JEPSON has become assistant superintendent of Chevrolet Proving Ground, Chevrolet Motor Division, GMC, Milford, Mich. Graduating from Michigan State College in 1931 with a B.S. degree in mechanical engineering, he served as assistant superintendent of the experimental engineering test department, in same company, for 4½ years.

WALTER H. RIGHTER, president and chief engineer of the Righter Products Co., Glendale, Calif., specializes in consulting engineering, design and development. A native of California, he received his bachelor's degree at C.I.T. in 1928, after majoring in mechanical engineering.

JOHN R. BOND, formerly sales engineer, Aluminum Industries, Inc., Detroit, is now working for Harley-Davidson Motor Co., Milwaukee, Wis.

Formerly process engineer, Spartan Aircraft Co., Tulsa, **WILLIAM E. RICHARD** has been appointed materials engineer for the City of Tulsa.

KENNETH C. GANO is now director of sales and advertising, Leece-Neville Co., Cleveland. Born in Chicago, he attended Shortbridge High School in Indianapolis and then graduated from Purdue University with a B.S. degree in mechanical engineering. Directly after that he joined Bendix Aviation Corp., N. Y.

WILLIAM C. BERGSTROM, who is treasurer of Air Carrier Engine Service, Inc., Miami, is one of the founders of the organization. Born in Lockwood, N. Y., he became interested in aviation at an early age and soloed at the age of 17 at Roosevelt Field, New York.

H. H. VOGEL has been appointed chief engineer of Champion Spark Plug Co., Toledo. He has had experience in all divisions of the engineering department, together with a great deal of work on production problems as related to engineering.

WILLIAM L. AIKEN has joined SKF Industries, Inc., Philadelphia, as senior division engineer in charge of the automotive and marine department. A graduate of the U. S. Naval Academy and Carnegie Institute of Technology, he was formerly executive engineer of the Autocar Co., Ardmore.

Schultheis, Bixby Promoted

Coincident with the retirement of **EDWIN B. ROSS,** vice-president in charge of sales of the Clark Equipment Co., and E. W. Clark, vice-president and general manager of the Tructractor Division, the appointment of **E. M. SCHULTHEIS** (in photo at left) as manager of sales has been made by **GEORGE SPATTA,** president. SAE vice-president representing the Truck and Bus activity and vice-chairman of the Detroit Section in 1944, Mr. Schultheis is chairman of the SAE General Membership Committee and has been active on numerous technical groups since 1933. **LEO A. BIXBY** was appointed manager of engineering of the Clark Equipment Co.

Leaving the NACA, **EUGENE B. LASKIN** is now conducting a business of his own, Laskin Mfg. Co., Baltimore, where he manufactures miniature engines for hobbyists. His first engine will be called "Circle 30" and will be marketed in the Spring.

New GM Vice-Presidents

JOHN F. GORDON
General Manager
Cadillac Motor Car Division

FREDERICK G. HUGHES
General Manager
New Departure Division

OLLIE V. BADGLEY
General Manager
Delco-Remy Division

Prior to his association with the Aeronautical and Marine Engineering Department, General Electric Co., Schenectady, N. Y., **JOHN P. JOSEPHS** was a lieutenant in the U. S. Army Ordnance Department.

MAX D. PETERS has currently taken a position as project engineer, Continental Aviation and Engineering Corp., Detroit, Mich. Mr. Peters had been a mechanical engineer with the NACA, Cleveland.

W. MARTIN-HURST, managing director, Teddington Controls, Ltd., Sunbury-on-Thames, Middlesex, England, is now located in South Wales.

A. H. KIBIGER, engineering stylist, Willys-Overland Motors, Inc., Toledo, Ohio, had been associated with Hudson Motor Car Co., Detroit, in the same position.

Having received his discharge from the U. S. Army, **HENRY C. MEYER** is now employed by Equipment Finance Corp., Chicago, Ill.

WALTER VAN VOORHEES is an engineering designer with Wickes Bros., machine tool manufacturers of Saginaw, Mich. He had been at the El Segundo plant of Douglas Aircraft Co., Inc.

Until recently with the central office of General Motors Corp., Detroit, **MILTON A. TRISLER** has been transferred to General Motors Holden, Ltd., Melbourne, Victoria, Australia. He made numerous contributions to the work of several SAE aeronautical committees prior to and since Pearl Harbor.

Now pulse jet project engineer for Continental Aviation & Engineering Corp., **FRED P. VAN DAME** was with Ready-Power Co., Detroit.

RALPH N. DUBOIS has been appointed professor of motors at the Aeronautical Institute of Technology of Brazil, Rio de Janeiro.

PHILIP B. LOVETT resigned from the Perfect Circle Corp., in order to become an instructor of mechanical engineering at Pennsylvania State College, State College, Pa.

ALBERT EDMUND MOREILLON is now affiliated with the Hymatic Engineering Co., Ltd., Worcestershire, England.

WALTER GROTHE, formerly assistant chief engineer of Caterpillar Tractor Co., San Leandro, Calif., has retired from business.

WILLIAM ERNEST HEADON has been appointed technical manager, E. P. Barrus, Ltd., London, England.

A graduate of the Case School of Applied Science, **KRELL EARL SPIRES, JR.,** has become a student engineer for Delco Products, Division of General Motors Corp., Dayton, Ohio.

J. HOWARD PILE has been promoted to business manager and editorial director of Fleet Owner, a monthly publication in New York City.

Now manager of the Stancil Motor Co., Gainesville, Ga., **J. RODERICK McKENNA** was master specialist of Eastern Airlines, Inc., Miami.

I. LOUIS CARRON has recently been named sales engineer of the Dura Division, Detroit Harvester Co., Toledo, Ohio.

C. W. KIRKPATRICK resigned from the Sun Oil Co., Ltd., Toronto, and is now connected with the Regent Equipment Mfg. Co., Ltd., also of Toronto.

JOHN G. WILSON has been named assistant research engineer with Engineering Research Associates, St. Paul, Minn.

Recently becoming body designer, Packard Motor Car Co., Detroit, Mich., **ALBERT V. APBLETT** was with Briggs Mfg. Co.

Returning to civilian life after serving in the Army, **ROY P. TROWBRIDGE** has become research engineer, General Motors Corp., Detroit.

Severing his partnership in the Bostrom Mfg. Co., Milwaukee, **T. L. SWANSEN** has become a consultant engineer, same city.

Graduating from Michigan State College, **MARVIN L. SMITH** has become detail project engineer, Pontiac engineer, Pontiac Motors, Mich.

Receiving his discharge **FRANK CHARLES KELLER** has become superviser of automobitive maintenance for Campbell Taggart Associated Bakeries, Dallas, Texas.

Formerly of Purdue University, **MARTIN PAUL KERCHELICH** has bee named test engineer of Pratt & Whitney Aircraft Co., East Hartford, Conn.

HENRY C. MEYER is now superintendent of operations, Equipment Finance Corp., Chicago, Ill.

RAYMOND D. McMULLIN is now serving Douglas Aircraft Co., Santa Monica, Calif., in the capacity of engineer.

GEORGE ANSON THOMPSON has been appointed superintendent of the British Columbia District of Canadian Pacific Air Lines, Ltd., Vancouver, B. C.

ROBERT C. JOHNSON, a recent graduate from Purdue University, is a research engineer at the Southern Research Institute, Birmingham, Ala.

Now staff assistant to the vice-president of operations of American Type Founders, Inc., Elizabeth, N. J., **WILLIAM RAYMAN NOLF** had been technical assistant to the master mechanic, Wright Aeronautical Corp.

J. F. WINCHESTER has been elected president of Davisbilt Products Co. of Cincinnati, Ohio, an affiliate of Liberty Aircraft Corp. Long an active member of the Society, he served on SAE Council and is a past-chairman of Metropolitan Section.

LEE C. DANIELS has been appointed chief engineer of Towmotor Corp., Cleveland, manufacturers of fork lift trucks and industrial tractors.

PAUL GRAY HOFFMAN, chairman of the Committee for Economic Development and president of the Studebaker Corp., South Bend, will be honored as a recipient of the 1946 award of the National Association of Public Relations Counsel, Inc., at a dinner held at the Hotel Plaza, January 15.

JOSEPH C. WILSON, who graduated from the University of Colorado, Boulder, is now affiliated with Douglas Aircraft Co., Inc., Santa Monica, Calif.

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TECHNICAL COMMITTEE PROGRESS

Hydraulic Brake Fluid Standards Insure Safer Motor Vehicle Braking

What constitutes a suitable hydraulic brake fluid for motor vehicles has been defined for the first time in a new standard approved by the SAE Technical Board. This new standard outlines minimum performance specifications and physical properties that a hydraulic brake fluid must demonstrate to be considered acceptable.

Two types of brake fluid are specified. One is a heavy duty brake fluid for use in an atmospheric range of 140 F to —60 F, in vehicles exposed to severe operating conditions; the other type, moderate duty brake fluid, is recommended for use in a range of from 130 F to —20 F, in vehicles where the fluid is not exposed to severe operating conditions.

Also specified in this standard – to appear in the 1947 SAE Handbook – are performance requirements of the fluid under such properties as boiling point, flash point, freezing point, rubber swelling, corrosion, stability, evaporation, and viscosity. Since uniform test procedure is a must in obtaining comparable interpretation of results at all times, the SAE standard spells out, in detail, both the test procedures and the test equipment to be used.

Strangely enough, this project is an outgrowth of a wartime situation involving the Army Air Forces. The possibility developed that large surplus stores of aircraft hydraulic fluid would be released to the civilian market where they might be sold for use in automobiles. This would have proved disastrous.

Rubber used in aircraft shock struts is synthetic and inert to that type of hydraulic fluid; but natural rubber in motor vehicle brake systems rapidly deteriorates when exposed to aircraft hydraulic fluid, rendering the brakes useless.

Fortunately, this situation was averted. The

SAE TECHNICAL BOARD

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Army Air Forces were apprised of the problem and steps were taken to prevent misuse of the surplus hydraulic fluid. But this incident brought to light the fact that there was no acceptable definition of what constitutes a suitable hydraulic fluid.

At the request of the Automobile Manufacturers Association, the SAE Non-Metallic Materials Committee undertook this job and created the Hydraulic Brake Fluid Subcommittee under the chairmanship of F. J. Markey, Moraine Products Division, GMC. Other engineers on this subcommittee were from leading vehicle, brake, and hydraulic fluid manufacturers.

Although the subcommittee has accomplished the mission assigned, it does not consider its job completed. It has appointed a small group to investigate further the problem of corrosion occasioned by hydraulic brake fluids since conclusions on this matter cannot be reached without long-term data.

When this group's studies show that present corrosion specifications can be improved, it will report back to the Hydraulic Brake Fluid Subcommittee. Members of the corrosion study group are H. R. Fife, Mellon Institute; K. E. Walker, E. I. du Pont de Nemours & Co., Inc., and G. L. Doelling, Mississippi Valley Research Laboratories.

Other members of the Hydraulic Brake Fluid Subcommittee are: T. J. Bagley, R. M. Hollingshead Corp; Burns Dick, Wagner Electric Corp.; S. R. Doner, Manhattan Rubber Mfg. Division, Raybestos-Manhattan, Inc.; J. D. Klinger, Chrysler Corp.; L. E. La Brie, Hydraulic Brake Co.; J. L. McCloud, Ford Motor Co.; Karl Pfeiffer, Chrysler Corp., and C. E. Zwahl, Chevrolet Motor Division, GMC.

SAE Sets Sights On Standard Studs

STANDARD studs being developed by SAE Committee E-26 will simplify stocking and servicing problems of both engine manufacturers and aircraft users.

This project, says Chairman Gustav Carvelli, Wright Aeronautical Corp, has reached the stage where industry can be advised of what to expect. Agreement has been reached to publish the final recommendations in the form of an Aeronautical Recommended Practice covering two types of studs in a number of sizes.

The two kinds of studs to be included are the stepped and the straight. (Diameters at each end differ in the stepped stud whereas they are the same in the straight type.) Each of the two will further be broken down as to stud body type and diameter. The Aircraft Screw Threads and Thread Fastenings Committee agreed that stud lengths can vary in 1/16-in. increments, although ⅛-in. increments are preferred.

Chart Light Plane Electrical Standards

ACHIEVING benefits of standardization in personal aircraft electrical equipment received full attention at the last meeting of SAE Committee A-2, Aircraft Electrical Equipment. Action taken consisted of establishing general environmental criteria and creation of subcommittees to tackle standards for specific items of equipment.

Chairman Edmund Thelen, Eclipse-Pioneer Division, Bendix Aviation Corp., reports that the following operating and environmental conditions will be considered in preparing standards for personal airplane electrical equipment:

a. Temperature: —20 F to +120 F;

b. Altitude: 0 to 15,000 ft;

c. Humidity: 20 to 100%;

d. Momentary acceleration (shock): Fuselage and engine – 6.6 G max, Wing and tail tips – 24 G max;

e. Vibration: Dependent on location in the plane; resonant frequencies should be avoided;

f. Sand and dust: Exclusion of same should be specified for exterior equipment. Usually it is not serious enough to warrant high cost or large weight expenditure for protection;

g. Corrosion: Vulnerable parts shall be protected;

h. Radio noise: Should be kept to a minimum without appreciable weight or cost increase;

i. Life test: Should be specified; it should not be rigorous in view of estimated plane use of 500-800 hr per year;

j. Voltage: 12 v;

k. Maximum power supply: Two 35-amp generators plus a 35-amp-hr battery.

Subcommittees appointed to prepare minimum performance specifications reflecting the above operating requirements are:

1. A-2A, Circuit Breakers – Under J. Ottman, Spencer Thermostat Co., this group will develop both performance specifications and dimensional standards for circuit breakers;

2. A-2B, Batteries – In addition to battery performance specifications, this group will develop dimensional standards reflecting present practice. Another job assigned to the subcommittee under H. C. Riggs, Electric Storage Battery Co., is the preparation of an Aeronautical Information Report on the relationship between battery weight and operating temperature.

3. A-2C, Control Equipment, Generators, Starters, and Relays – Both environmental specifications and dimensional standards for items under its cognizance will be prepared by this subcommittee under J. B. Hiday, Delco-Remy Division, GMC.

4. A-2D, Motors – L. F. Hemphill, General Electric Co., will guide the group in development of both performance specifications and dimensional standards, providing separate motor specifications where needed for special applications.

5. A-2H, Harnesses – In developing general performance specifications for personal aircraft cable, L. C. Wolcott, Packard Electric Division, GMC, and his group will review AN-JC-48 and also consider the use of automotive type cable.

6. A-2K, Switches – Several types of switches will be considered in development of performance specifications. Heading this project is L. Mayer, Cole-Hersee Co.

7. A-2L, Lights and Lighting – L. B. Moore, Grimes Mfg. Co., will chairman this group in the preparation of specifications covering panel, landing, position, and cabin lights. Up for consideration is an Aeronautical Information Report to establish the relationship between landing light intensity and the type of light with speed and general configuration of the airplane.

Recent AMS Display Broad Field Covered

REPRESENTATIVE of the wide scope of SAE Aeronautical Material Specifications are the recently issued specifications – both new and revised – for plastics, aviation fuels, and copper alloys, reports AMS Subdivision Chairman J. B. Johnson, Air Materiel Command.

The aircraft industry is finding many uses for plastics in nonstructural applications such as flooring and airliner furnishings. Prepared by a committee under R. R. Janssen, North American Aviation, Inc., the following final-product specifications – first of their kind for aircraft plastics – promise to simplify purchasing:

- AMS 3605 – Plastic Sheet, Post-Forming, Cotton Fabric Reinforced Phenol-Formaldehyde,
- AMS 3620 – Plastic Mouldings and Extrusions, Polystyrene,

• AMS 3621 – Plastic Mouldings and Extrusions, Ethyl Cellulose,

• AMS 3622 – Plastic Mouldings and Extrusions, Cellulose Acetate,

• AMS 3624 – Plastic Mouldings and Extrusions, Cellulose Acetate Butyrate,

• AMS 3626 – Plastic Mouldings, Methyl Methacrylate,

• AMS 3641 – Plastic Moulding – Thermosetting, Phenol Formaldehyde-Macerated Fabric Filled.

Another first-of-their-kind specifications are the aviation fuels AMS, developed by the Petroleum Products Commodity Committee chairmanned by G. K. Brower, American Airlines, Inc. Need for these stemmed from experience indicating that economy and safety in commercial aviation called for fuels of the type described in these new specifications. They are:

• AMS 3028 – Aviation Fuel, Grade 91/98,

• AMS 3032 – Aviation Fuel, Grade 100/130,

• AMS 3036 – Aviation Fuel, Grade 122/146.

Just as the AMS Subdivision's commodity committees are alert to the need of industry for new specifications, they also keep existing AMS abreast of changes. These copper alloy AMS, revised by the group under R. J. Metzler, Breeze Corporations, Inc., are an example of the committees' efforts to keep the specifications up-to-date with current practice:

• AMS 4510B – Phosphor Bronze Strip, Spring Temper,

• AMS 4520C – Bronze Strip,

• AMS 4610C – Brass Rods and Bars, Free Cutting – Half Hard,

• AMS 4611A – Naval Brass Rods and Bars – Half Hard,

• AMS 4614C – Brass Forgings,

• AMS 4615A – Silicon Bronze Bars, Hard,

• AMS 4619A – Manganese Bronze Forgings,

• AMS 4625C – Phosphor Bronze Bars, Hard.

Journal Index Available

A complete Index covering the twelve 1946 issues (Vol. 54) of the SAE Journal is now available to members and subscribers free upon request.

Aero Parts Packaging Aims Oriented to Airline Needs

Packaging Procedures

AIRCRAFT parts preservation and packaging procedures geared to airline operators' needs is the aim of the postwar program being tackled by SAE Subcommittee S-6A.

Recently reorganized, this committee is emphasizing the need for both modifying and expanding, for commercial airlines, those procedures developed by its wartime predecessor. It expects to prepare procedures for all aircraft parts except airframe items. (The war job covered only engine parts.) Reports of equipment ruined in recent overseas shipping operations point to the airline needs for up-to-date procedures.

Committee Chairman P. J. Kondla, Pratt & Whitney Aircraft, says his group will generalize recommended packaging instructions without losing their utility. Instead of procedures for each individual item, equipment similar in nature will be grouped together. One such grouping will be assemblies harmed by contact with oil, such as electric motors and instruments.

Each section of the procedures – cleaning, preservation, dehydration, interior and exterior boxing, and markings – has been assigned to one committee member for review and preparation of a proposal. G. R. Johns, United Airlines, Inc., has the job of advising the Committee on current needs of airline operators.

Serving with Chairman Kondla and Mr. Johns on the Committee are R. G. Anderson, Sperry Gyroscope Co., Inc.; R. N. Hait, Wright Aeronautical Corp.; R. P. Lambeck, Hamilton Standard Propellers; R. D. Nay, Surface Combustion Corp.; E. P. Riley, Thompson Products, Inc.; D. R. Scott, Allison Division, GMC; E. W. Stetler, Jack & Heintz Precision Products, Inc.; R. D. Williams, Aircooled Motors Corp.; G. H. Lamore, Jacobs Aircraft Engine Co.; J. R. Orgain, Chandler-Evans Corp., and B. L. Sharon, Lycoming Division, The Aviation Corp.

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Moisture Barriers

WARTIME moisture barrier specifications are being streamlined to meet commercial aviation's preservation and packaging needs.

Chairman B. L. Sharon, Lycoming Division, The Aviation Corp., describes the job of Subcommittee S-6C as a reviewing operation to adapt existing specifications to SAE's postwar preservation and packaging program. Parent Committee S-6 has assigned this group the task of revising AMS 3610A, Plastic Film – Transparent, Moisture-Vapor Resistant, and AMS 3540 and AMS 3542 on grease-proof wrapping paper.

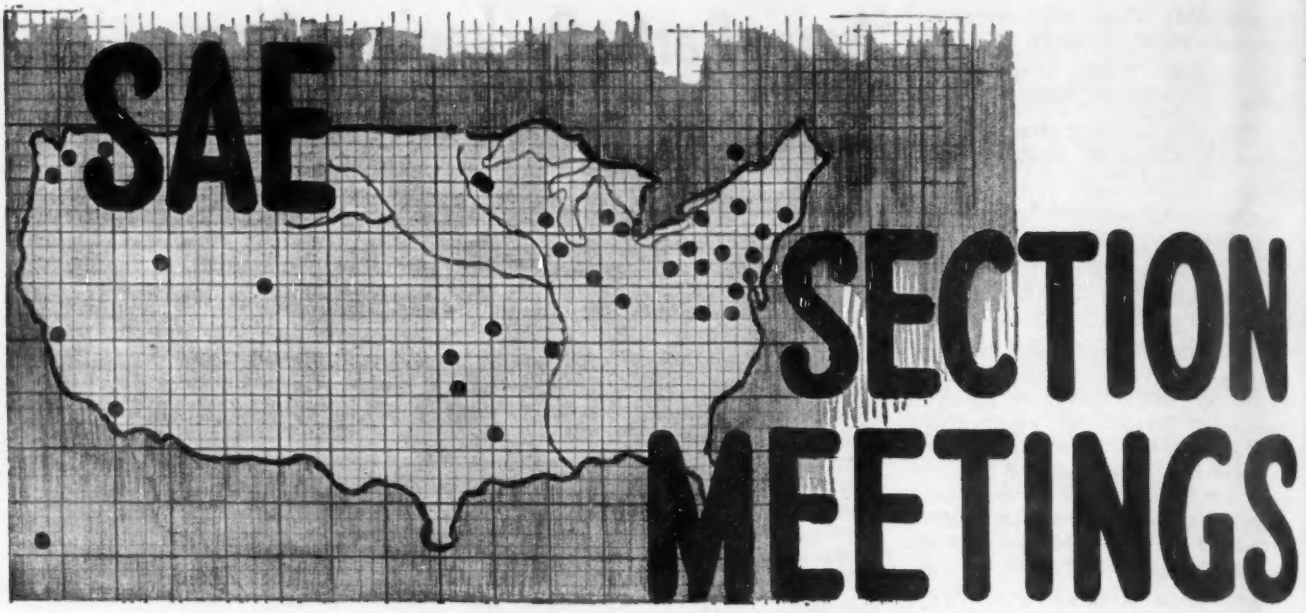
Changes in these AMS will be governed by differences between military and civil aircraft requirements and will keep pace with industrial packaging advancements.

Members of the recently reorganized Moisture Barriers Subcommittee are Chairman Sharon; D. J. Jorgensen, Davison Chemical Corp.; W. B. Tibbets, The Dobeckmun Co.; J. C. E. Williams, Goodyear Tire & Rubber Co.; W. L. Hardy, Protective Coatings Corp., and R. L. Lee, Shellmar Products Corp.

Committee Chairmen

P. J. Kondla

B. L. Sharon



Engineers Urged to Prepare for 100 Octane

by L. A. WILSON, Field Editor

MILWAUKEE Section, Dec. 6 – Automobile industry was challenged at this meeting to get out of the 1942 stage of motor car development and into the 1948 stage. "The automotive engineer has a job to prepare for 90 or 100 octane fuel," Dr. Gustav Egloff of Universal Oil Products Co. declared. However, we are headed in that direction. In support of this contention, he cited the extensive facilities and techniques developed during the war for manufacturing high octane gasoline by the various catalytic cracking, alkylation, and hydrogenation processes.

Egloff believes improved 100 octane fuel should increase efficiency 50% over prewar 76 octane. Even at 5¢ more per gal, 100 octane probably would be more economical.

"We need have no fear of running out of oil," he said. "However, in the event that we do, we have technical processes for converting coal or natural gas into carbon monoxide and hydrogen by oxidation, after which these two gaseous molecules can be combined to form liquid hydrocarbon molecules." Elaborating on the potentialities of natural gas and coal as sources of oil, Egloff stated that there are 185,000,000,000 cu ft of gas in known gas fields, and three trillion tons of coal in the United States alone, potentially enough for 2000 years' oil supply. He mentioned that one large oil company is doubling its research staff and spending 30% of its income on a program for converting coal to gasoline.

"Present fuels have too many hydrocarbons in them," he asserted. "Every one of these has a different rate of oxidation. Fewer would be better. Combining carbon monoxide and hydrogen, we can actually design the structure of the hydrocarbon desired."

Texas Section Names Houston Vice-Chairman

by EARL L. CASEY, Field Editor

TEXAS Section, Dec. 13 – First SAE meeting ever held in Houston was attended by 40 members who heard W. W. Finlay discuss important inventions from the wheel to the airplane. Finlay, who is executive vice-president and general manager of the Guiberson Corp., Dallas, evaluated beneficial and destructive influences of these steps in the march of progress. Engineers, he added, are too much individuals who spend too much time perfecting ingenious devices, not enough time educating the general public to the uses of these devices. Questions following his paper dealt mainly with negotiations with foreign countries, a field in which Finlay is expert.

Jay Resigns As Texas Chairman

Acting in accordance with doctor's orders, S. V. Jay has resigned his post as chairman of the Texas Section. The Governing Board of the Section accepted his resignation with deep regret. Jay is succeeded as chairman by Floyd Patras, formerly vice-chairman. John T. Wade has been named to fill the post left vacant by Patras. Texas Section recently created the post of vice-chairman to represent the Houston area, naming Claude Peebles to this office.

Calls Torsilastic Springs Solution to Many Problems

by J. B. TOMPKINS, Field Editor

BRITISH COLUMBIA Group, Dec. 11 – Rubber springing represents an engineering advance possibly equal to any other design improvement in recent years, W. R. Hubka told this meeting. Over 150 members heard the west coast sales manager of the Twin Coach Co. of Kent, Ohio, speak on "Installation of Torsilastic Springs in Motor Coaches."

Torsilastic bus springing, he said, has solved the problem of a spring suspension stiff enough to absorb overloads yet flexible enough under light road disturbances to react without unnecessary jarring. Used extensively on military units in every battle sector, Torsilastic rubber springing uses synthetic rubber as a torsion member. The rubber is bonded to the center steel tube and encased in a fixed outer shell. The outer shell is bolted to the bus axle with the center rubberized tube turning slightly due to weight exerted by the motor coach. Springing, he claimed, takes place through the flowing motion of the encased rubber. Motion of the center tube is dampened, as in conventional springing, by shock absorbers. Coach body is suspended on rubber bushed shackles that connect to center tube through suspension arms.

Leading advantage of Torsilastic springing is the virtual elimination of initial starting friction or inertia required to set conventional springs in motion. Hubka explained that this reaction to leaf springs becomes noticeable not on rough or bumpy roads but on smooth highways when the cross-

sectional lines created in the construction of the "smooth highway" are "telegraphed" up through the body and running gear "to an extent that makes you wonder if the vehicle has a flat tire." "This condition," he explained, "was caused by the fact that the impact or shock-loading was not of high enough magnitude to break the friction or starting inertia. Other than the cushioning afforded by the tires themselves, the vehicle actually was running without benefit of springs under these circumstances."

With the new springing, there are no bearings to lubricate; no squeaks or rattles; no friction; the ability to absorb shocks from all directions; a soft, elastic ride; reduction of outward "swing" on curves; minimum change in floor height, empty or loaded; no abrasion, rusting or wearing action from dirt, road salt, water, or mud.

Shock absorbers still are necessary, Hubka said during discussion of his paper, since rubber must be compounded to act the same under all load conditions; under heavy loads, it would have a tendency to bounce without shocks. Weather, he told the rain and mud-wise truck and bus operators in pavement-poor British Columbia, has had no effect on rubber used under all weather conditions on Twin Coach models equipped with the new springing. Steering geometry is not affected since the spring is bolted to the axle and its setting does not vary with body movement. Springs are longitudinal and "fixed fore and aft" of the axle. Synthetic rubber has been proved immune to road oils, and has more elastic qualities than natural rubber.

A manufacturer of logging trucks and trailers asked about maximum capacity. Maximum used by Twin Coach, Hubka said, is a 37-passenger unit with a gross weight of 28,460 lb loaded. The company's test model has operated some 500,000 miles, and been mechanically "bounced" with a load equivalent to that of a 40-passenger bus.

Transsonic Hazards Bar Passenger Travel

by A. M. WATSON, Field Editor

SOUTHERN NEW ENGLAND Section, Dec. 4 – The average aircraft passenger probably will prefer to "dolt it" at subsonic speeds for some time to come, rather than run the gauntlet of the powerful forces toying with aircraft traveling into or through the transsonic speed range. This point was graphically emphasized by Dr. W. F. Hilton, of the Applied Physics Laboratory at Johns Hopkins University, in a discussion of some of the characteristics of shock waves as seen in wind tunnel tests.

The transsonic range, roughly considered as from 0.75 to 1.00 Mach number, persistently remains as a formidable barrier to supersonic flight. The specific speed rate at which shock waves seriously begin to upset airflow patterns over lift surfaces may be delayed at higher altitudes or even by aircraft with sweptback wings, but sooner or later the dangerous range must be met.

When the shock wave forms, roughly perpendicular to the airflow and generally at the leading edge of the airfoil, a "break-away point" is created behind which the air refuses to follow closely the airfoil contour. As speed increases, this break-away point moves aft with the increasingly strong shock wave. The break-away wake becomes wider and the resultant drag greater. Aircraft control surfaces become useless and lift is reduced, since the break-away wake is merely turbulent air of subsonic speed.

Hilton emphasized that the slides he showed were not actually those of shock waves, as the waves are infinitesimally thin. However, the camera is able to discern in a fraction of a second the shadow of light refracted by the condensed vapor which closely follows the passage of the shock wave.

Although thinner wings are more desirable for the higher speeds in order to reduce drag, limits of structural strength soon are met. Even refrigeration becomes a necessity, since skin temperature increases as the square of the velocity. The V-2's, after traveling at speeds up to 3.5 Mach number, would glow a dull red when coming to earth.

Following Hilton's discussion, Frank W. Caldwell, director of research, United Aircraft Corp., reported that in the development of propellers to absorb greater powers, the speed of sound has for some time provided a decided limitation to blade tip speeds. Use of wider blades, a greater number of blades, and reduction gearing in the aircraft engine all have succeeded so far in absorbing the ever increasing power ratings. However, it is apparent now that the airframe industry has reached the same barrier in a common problem.

Flight Testing Report Inspires Lively Meeting

by C. W. SIMMONS, Field Editor

SYRACUSE Section, Oct. 22 – This Section's interest in flight testing was evidenced tonight by the fact that it was almost necessary to douse lights to halt questions and discussion. Speaker Dexter Rosen, Bell Aircraft Corp. engineer, illustrated his paper on "Flight Testing Takes Teamwork" with a sound film.

This was a joint meeting, held at the Syracuse Museum of Fine Arts with the Syracuse Technology Club.

Past-Chairmen Join Forces to Make One of Canada's Best SAE Meetings

by WARREN HASTINGS, Field Editor

CANADIAN Section, Nov. 20 – Canadian Section's past-chairmen's meeting proved one of the most felicitous functions in its history. Success was insured by the efforts of some of the past chairmen – notably Col. Alex McArthur, the Section's second chairman, its first surviving first officer, and a past vice-president of the Society. Among his other preparatory labors, McArthur, who is assistant general manager of the Toronto Transportation Commission, served as host at a

Dignitaries at Canadian Section's past-presidents' meeting included Col. Alex McArthur (left), dean of past-chairmen extant, C. E. McTavish (center), present chairman, and George J. Beattie, last year's chairman. Behind Beattie's head on the windowsill is (still wrapped) the electronic gavel he presented to the Section

luncheon of past chairmen and senior Section officers. He presided at the dinner meeting following the brief business session, during which Chairman C. E. McTavish occupied the chair.

After assuming the gavel, McArthur described the Section's inaugural meeting, minutes of which were subsequently read by its then and now secretary, W. B. Hastings, acceptance of whose resolution, seconded by the Section's third chairman, George W. Garner, brought the Section into being over 18 years ago.

Other past-chairmen who participated in the program were 1945 Chairman George J. Beattie, Col. Max Evans, John L. Stewart, W. E. McGraw, George W. Garner, Former Councilor James C. Armer, Charles E. Tilston, Neil Petersen, Councilor Marcus L. Brown, and Alex Gray.

Past-Chairman and Past-Councilor Bill McGraw, a member of the National Nominating Committee, spoke on "The Society," reviewing SAE achievements from the days of Henry Ford's "99 Racer" and Barney Oldfield's "Green Dragon."

Armer and Petersen, both past-chairmen and past-councilors, spoke on "The Council, Section and Activities of the SAE" and "What's Ahead?" Petersen forecast, in part: higher motor car prices; 100,000-mile tires of rubber and synthetics; replacement of present coil and flat steel springs with torsion bars combining steel and rubber; more efficient operation through improvements in engines and their fuel; use of fluid couplings and torque converters instead of clutches.

HAMMOND
. . . . of Baltimore

Lloyd J. Hammond, Baltimore Section chairman, is an old timer in the automotive field. He first saw the light of day in Baltimore, where he received his schooling. He launched immediately into the automotive world after his graduation from Franklin High.

His first job was with the Front-

Lloyd J. Hammond

Wheel-Drive tractor organization as service engineer. Several years later he moved in with the old Earl motor car as service manager for the Maryland distributor. In 1922 he joined White Motor Co. as territory field engineer. In 1930 he established the firm which now bears his name, and in which he is senior partner. Hammond & Seidel is one of Baltimore's outstanding truck service and engineering organizations, and is recognized as such by fleet owners along the entire Atlantic Coast.

An asset to SAE just as he is to his community, Hammond never misses a meeting. – by Arthur G. Moran, Field Editor.

WERNER
. . . . of Pittsburgh

Norman H. (Red) Werner is one of those valuable Section chairmen who focuses the spotlight on other rising members of the Section by giving them positions of responsibility at meetings, thus insuring continued interest in and success of the Section. Since Pittsburgh is fundamentally an operations and maintenance center, riding on a beautiful blue cloud of oil, the Section wisely chose a fleet operator to keep it in tune with member interests. By holding Governing Board meetings prior to each meeting, he has increased the feeling among members that each meeting is "their show."

Born in Pittsburgh, Dec. 29, 1897, Norman attended Carnegie Institute of Technology where he took a three-year course, specializing in electrical engineering. When World War I interrupted, he enlisted in the U. S. Marine Corps, where he served for a year. He started in the transportation business in 1920 with the Ed Werner Transfer &

Norman H. Werner

Storage Co., and has managed the company since 1942.

Speaking as a fleet operator, Norman says, "SAE Section meetings have afforded me a valuable post graduate course, under pleasant conditions, in automotive transportation." He joined the SAE in 1941. – by Murray Fahnestock, Field Editor.

This is the fifth installment in a series of biographies of 1946-47 SAE Section chairmen. Next month three more field editors will report on their Section chairmen.

MEYER
. . . . of Cincinnati

Wilburn E. Meyer, Cincinnati's chairman, is a recent but faithful SAE member. He joined the Society originally at the Dayton Section in 1943, and in 1944, when the Cincinnati Section was chartered, he served as vice-chairman for two years. He is also an active member of the Engineering Society of Cincinnati.

A native of Kentucky, Meyer studied mechanical engineering at Brown University and highway engineering at the University of Cincinnati.

He is a veteran automotive engineer. Since 1907 he has served with many organizations including Ford Motor Co., Maxwell Motor Car Co., Armleder Truck Co., and Studebaker Motor Car Co. He claims the honor of having driven the first 6-cyl Studebaker ever built.

In 1926 he was appointed by the Civil Service Commission of Cincinnati as supervisor of equipment in the Highway Maintenance Division. He has just celebrated his twentieth year in this capacity.

His chief hobby is photography. With his family he has made extensive trips throughout the country. He has fished from the Georgian Bay to the Gulf of Mexico, and also experienced the thrill of hunting coyotes in the hills of South

Wilburn E. Meyer

Dakota. His jovial nature makes the experiences of these various trips the source of many tales. – by Harold B. Frye, Field Editor.

Chilton Editor Predicts Major Engine Changes, Gas Turbines Long Before Atomic Power Engines

by R. W. DONAHUE, Field Editor

PHILADELPHIA Section, Dec. 11 – Major changes in motor car engines to take advantage of higher octane fuels are necessary and to be expected. Another reason for change, Joseph Geschelin told SAE members at this meeting, is that most present engines have about reached the area of diminishing returns so far as further improvement in performance or output or fuel economy is concerned.

At the same time, the Detroit Editor of Automotive & Aviation Industries pointed out, engine designers deserve much credit for staying within the limits of a basic engine design and still progressively improving specific output, performance and fuel economy.

Four important stimuli to radical change, he said, are

1. Competition.
2. The law of diminishing returns.
3. The trend toward lighter cars requiring lighter engines.
4. Pressure of advanced manufacturing methods.

For the distant future, he believes, gas turbines are closer to practicability than atomic or fission energy motors, since large-output gas turbines already have been built and have given excellent performance. It may be five years before the specialists in that field are able to examine the possibility of scaling down the size of the gas turbine for passenger car outputs under 100 hp.

Too little is known about fission energy for reasonable prediction. Some experts believe installations somewhat smaller than 50 tons are feasible, but these would serve only military aircraft, being considerably larger than anything required for passenger cars or trucks.

Visitor to the Philadelphia Section from England, George Eyston (right) of the C. C. Wakefield Co., London, and E. C. Paige, Ethyl Corp., exchange views while waiting to hear Joseph Geschelin discuss possible changes in new cars. G. A. Richardson is in the background. Eyston, one time race car driver, drove Britain's famous "Thunderbolt" on the Salt Flats in Utah in 1937-38, averaging 357.5 mph.

Two Activities Produce Detroit Section Meeting

by W. F. SHERMAN, Field Editor

DETROIT Section, Dec. 2 – A diversified diet was presented to Detroit Section members at the Dec. 2 meeting, which was a joint Aeronautic and Production session.

Dr. Arnold Keuthe, professor of aerodynamics, University of Michigan, spoke on "Flight at Supersonic Speed" and J. H. Mansfield, chief engineer, Greenlee Bros. & Co., spoke on "Transfer Machines – Robots of Production." Wilbur Shaw, head of the Indianapolis Speedway, dinner speaker at a meeting a year ago, was such a drawing card that he was presented to the entire audience at this session and showed a Firestone technicolor picture on the history of the Speedway, along with some reminiscences of his own.

Flight at supersonic speed must first get over the hurdles interposed by the transsonic range, Keuthe declared. Work with missiles has provided theory and a background of experience so that supersonic aircraft will encounter phenomena that are at least predictable, but there is no framework for making predictions in the 600-900 mph range. Wind tunnel test results have been proved not reliable in this range, he asserted.

Short waves, mentioned frequently in connection with flight at extremely high speeds, result because there are "no messengers above the speed of sound to warn the air ahead of the airfoil," Keuthe said. He had prefaced this by indicating that at slower speeds such "warnings" were transmitted to prepare the air for the passage of the wing, somewhat as water parts at the prow of a vessel.

The Production Activity presented Mansfield because of current interest in the process machine, as contrasted with machines performing single operations. He defined this type of equipment as consisting of combinations of several individual machine units, either in a transfer machine or in a circular table indexing type machine. The idea is not unlike the old-fashioned bucket brigade for fighting fires, he said.

Mansfield's first experience with the transfer idea was about 1920 when one automobile company designed equipment which would complete all operations on certain automobile parts. However, at that time hydraulic feeds and electric control equipment had not yet been developed to the point where they were practical for this application.

Some of the most spectacular machines of this sort were built during the war for the machining of aircraft cylinder heads. A current machine of the sort is one for processing an automobile crankcase. In this application there are 428 cutting tools used in the transfer line, which requires 12 operators, three tool setters and half of an electrician's time.

If careful analysis of operations to be performed indicates that the work piece has only one or two faces, with simple operations, the indexing type of machine is preferable because these machines have fewer heads, head feed units and frames, he declared. On the other hand, work requiring many operations at different angles is best handled on the transfer machine, Mr. Mansfield said.

The talk was well illustrated with pictures and references to specific operations and parts.

As to the future, developments in electric and hydraulic mechanisms may be expected. Some machines with electronic controls for variable speed motors are now being operated.

Record System Outlined For Truck Maintenance

by R. W. BIXLER, Field Editor

SOUTHERN CALIFORNIA Section, Nov. 14 – "Proper maintenance of equipment is the only answer to successful operation of a trucking business," Harry E. Larson told this meeting. Larson, who is fleet and maintenance superintendent for Pacific Intermountain Express Co., spoke on "The Maintenance of Heavy-Duty Diesel Trucks on the Highways and the Control of Smoke and Noise," pointing out that proper maintenance demands good records. Four hundred members and guests heard him outline such a system of records:

1. An equipment register sheet for each piece of rolling stock, to record

Turn to p. 107

1947 NATIONAL MEETINGS CALENDAR

AERONAUTIC (Spring)
Hotel New Yorker,
New York
• April 9-11

TRANSPORTATIO
The Stevens,
Chicago
• April 16-18

PERSONAL AIRCRAFT
The Lassen,
Wichita, Kans.
• May 1-2

SUMMER
French Lick Springs Hotel,
French Lick, Ind.
• June 1-6

WEST COAS
T & M
Biltmore Hotel,
Los Angeles
• Aug. 21-22

TRACTOR
Hotel Schroeder,
Milwaukee, Wis.
• Sept. 17-18

AERONAUTIC (Autumn)
Biltmore Hotel,
Los Angeles
• Oct. 2-4

PRODUCTION
Carter Hotel,
Cleveland
• Oct. 20-21

FUELS & LUBRICANTS
The Mayo,
Tulsa
• Nov. 6-7

AIR TRANSPORT
Hotel Continental,
Kansas City, Mo.
• Dec. 1-3

ANNUAL
Hotel Book-Cadillac,
Detroit
• Jan. 12-16, 1948

CALENDAR of Section Meetings

Baltimore – Feb. 13

Koppers Co., Inc., Piston Ring Division; dinner 7:00 p.m. Oyster Roast. Tour of American Hammered piston ring plant. Conducted by – A. W. Morton, vice-president and general manager, Piston Ring Division, and Leonidas Doty, Automotive Division, Koppers Co., Inc.

British Columbia Group – Feb. 12

Hotel Georgia, Vancouver; dinner 7:00 p.m. Types and Processes of Welding – C. Arthur Lind, Scott Foster & Co., Ltd. Motion Pictures.

Chicago – Feb. 11

Hotel Knickerbocker; dinner 6:45 p.m. Harvesters Diesels as Used in Industrial Power Equipment – W. O. Bechman, chief engineer, Industrial Power Division, International Harvester Co.

Cincinnati – Feb. 10

Hotel Alms; dinner 6:30 p.m. Jet and Turbine Engine Development – R. P. Atkinson, assistant turbine engineer, Allison Division, General Motors Corp.

Cleveland – Feb. 10

Cleveland Club; dinner 6:30 p.m. Use of Single and Dual Engine in the Present and Future Bus Operations – William DeCapua, chief production engineer, Twin Coach Co.

Dayton – Feb. 19

Hotel Van Cleve; dinner 6:30 p.m. Aircraft Propulsion – J. F. Haines, director of research, Aeroproducts Division, General Motors Corp.

Detroit – Feb. 3 and 17

Feb. 3 – Horace H. Rackham Educational Memorial Bldg.; dinner 6:30 p.m. Dinner Speaker – George Stark, The Detroit News. Subject – The Little Doctor. Application of Fuels to Engines – Dr. W. G. Lovell, assistant head, Organic Chemistry, Research Laboratory Division, General Motors Corp. Engine Cooling – B. W. Bogan, engine head, Cooling Department, Chrysler Corp.

Feb. 17 – Horace H. Rackham Educational Memorial Building; meeting 7:30 p.m. Aircraft Powerplants of the Future – Lovell Lawrence, Jr., president, Reaction Motors, Inc.

Indiana – Feb. 13

Hotel Antlers, Indianapolis; dinner 6:30 p.m. Directional Stability of Vehicles in Motion – W. K. Creson, vice-president, engineering, Ross Gear & Tool Co.

Metropolitan – Feb. 4 and 20

Feb. 4 – Hotel Pennsylvania, New York; meeting 7:45 p.m. Navigational Aids in Air Transport – W. A. M. Burden, assistant secretary of commerce. J. M. Van Law, vice-chairman, Air Transport Activity.

Feb. 20 – Hotel Pennsylvania, New York; meeting 7:45 p.m. Suspension Requirements of Unsprung Parts – A. S. Krotz, B. F. Goodrich Co., and Robert Schilling, General Motors Corp. Roy Brown, Firestone Tire & Rubber Co., will act as moderator. D. F. Geisey, vice-chairman, Passenger Car Activity.

Mid-Continent – Feb. 7

Hotel Mayo, Tulsa; afternoon session – Junior Ballroom; 4:30 p.m. Report on the National Meeting in Detroit. Members Only; dinner 6:30 p.m. Evening session – Ivory Room. American Airlines' Evaluation of Airborne Radar – Frank C. White, American Airlines Engineering Department.

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Mohawk-Hudson Group – Feb. 18

Hotel DeWitt Clinton, Albany, dinner 6:45 p.m. Rockets – F. P. Porter, General Electric Co.

Northern California – Feb. 8

Hotel Claremont, Oakland; dinner 7:30 p.m. Annual Dinner-Dance.

Oregon – Feb. 14

Hotel Imperial; dinner 7:00 p.m. Redesigning for Improved Performance and Life of Modern Engines – L. L. Bower, assistant chief engineer, Waukesha Motor Co.

Peoria – Feb. 24

Hotel Jefferson; dinner 6:30 p.m. Speaker – C. E. Frudden, consulting engineer, Tractor Division, Allis-Chalmers Mfg. Co., and president SAE.

Philadelphia – Feb. 12

Engineers Club; dinner 6:30 p.m. Wide Base Tires and Rims – W. S. Brink, Firestone Steel Products Co.

St. Louis – Feb. 11

Hotel De Soto; dinner 6:30 p.m. Engine Lubricants – C. M. Larson, chief consulting engineer, Sinclair Refining Co.

Southern California – Feb. 6

Biltmore Hotel, Los Angeles; meeting 8:00 p.m. Powerplant Requirements for Personal Aircraft – Peter Altman, engineering consultant. Design Trends in Turbo-Jet and Turbo-Prop Engines – E. V. Farrar, manager, Gas Turbine Division, Wright Aeronautical Corp.

Southern New England – Feb. 5

Hotel Bond, Hartford; dinner 6:45 p.m. Patents and the Engineer – C. L. Shelton, director, Patent Section, United Aircraft Corp.

Spokane Group – Feb. 14

Hotel Desert; dinner 7:00 p.m. Torsion Suspension on Heavy Duty Trends – W. M. Brown, project engineer, Kenworth Motor Truck Co.

Syracuse – Feb. 3

Syracuse Museum of Fine Arts; dinner 6:30 p.m. Passenger Car Trends and Developments in Engine Design – Joseph Geschelin, Detroit Editor, Chilton Co. Joint meeting with Technology Club.

Washington – Feb. 11

Hotel Twenty-Four Hundred; dinner 6:30 p.m. Mind Reading – L. W. Slefe. Ladies' Night.

Western Michigan – Feb. 20

Hackley Art Gallery, Muskegon; meeting 7:30 p.m. Atomic Energy – Prof. E. F. Barker, University of Michigan.

Wichita – Feb. 13

Airway Cafe; dinner 6:45 p.m. Some Aspects in the Design of Modern Highways and Airport Runways – O. O. Ediger, Ediger Engineering Co. Impromptu Dinner Speaker.

Williamsport Group – Feb. 3

Home Dairy; meeting 7:45 p.m. Jet Propulsion and Rockets – M. W. Nesbitt, chief engineer, Reaction Motors, Inc.

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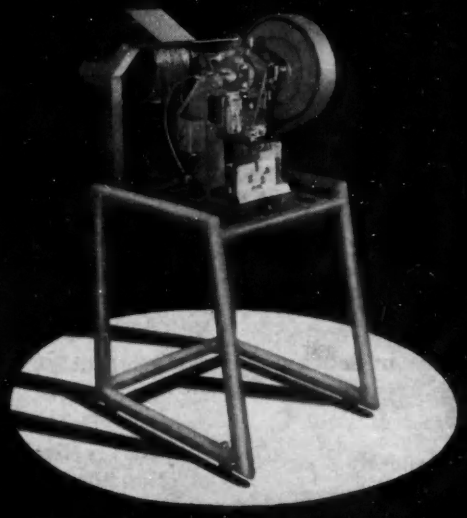

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Student Branch News

General Motors Institute

The SAE Branch of General Motors Institute featured a field trip to Fisher Body Plant No. 1 on the evening of Dec. 11. Approximately 60 students took part in the plant trip and in the annual dinner which followed in the plant cafeteria.

To give a more intimate picture of problems of manufacturing an all steel body and to answer questions suggested by either the plant trip or the short talk, the group adjourned to a conference room for a meeting which lasted over an hour. E. N. Krecke, general superintendent, North Unit and Assembly, very graciously answered any questions which were brought up by members of the group. This turned out to be a very worthwhile activity on an important subject, since manufacturing a sheet metal body to accurate dimensions is just about the hardest problem anyone could ask for.

Massachusetts Institute of Technology

"Future Automotive Engines," was the title of a lecture delivered by Prof. C. F. Taylor, Automotive Engineering Dept., M.I.T. at the Dec. 10 meeting of the SAE Student Branch.

Taylor saw no spectacular changes in automotive power in the foreseeable future. The jet is definitely not in the picture, he declared. Its low efficiency at low speeds and the bad effects of its exhaust on pedestrians are its main drawbacks. As for the gas turbine, he continued, it is more plausible than the jet, but since it is essentially a constant speed machine, very elaborate transmissions would be needed on automobiles. The remainder of his discussion, therefore, was confined to possible modifications of the existing automobile engine.

The first question considered was the possibility of a change in cylinder arrangement from the existing vertical arrangement and V-type set-up. The logical location for an engine is either at the front or the back of the automobile. The forward location is appropriate for a narrow engine. Because of the space in which the front wheels turn, the remaining space is not adequate for a horizontally opposed engine. The rear compartment has enough space for a horizontally opposed engine or even a radial engine, but the drawback in weight distribution, and the little space in the forward compartment for luggage, point to the continued use of the present arrangement.

Taylor did not anticipate the advent of front-wheel drive as a common thing because of the bad characteristics it displays in driving on icy roads.

According to the professor, automatic transmission is very near. More speed steps, which mean greater fuel economy, will probably appear. Other

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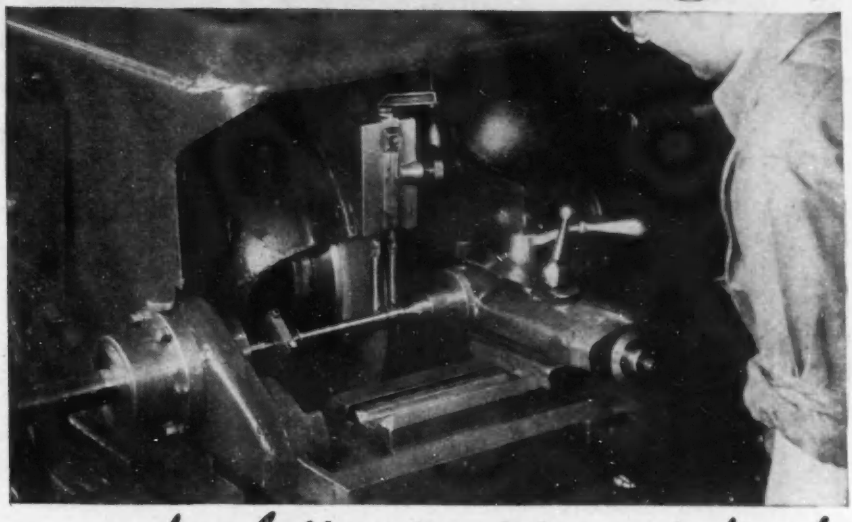

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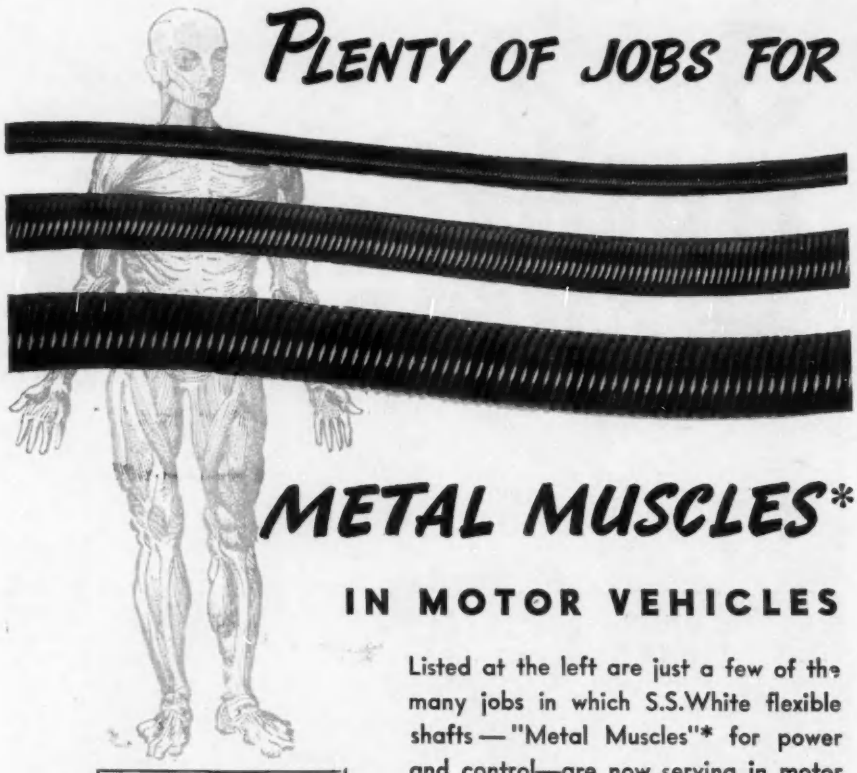

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improvements will also enhance fuel economy. The octane rating of fuels is steadily rising, and by 1950, according to a conservative estimate, the octane numbers should be about 86 for premium gasoline and 80 for the regular. A rise in compression ratio and smaller, supercharged engines would also aid fuel economy. The supercharged engine, however, is not likely to appear soon, because, even though smaller, provision must be made for higher stresses resulting from higher manifold pressures, and more parts are required. These things make the price of the supercharged engine much higher than that of the conventional engine.

The use of diesel power in the family automobile is also not likely. The diesel is heavier than the gasoline engine, is more expensive, and likes to operate under heavy load. The gasoline engine is efficient at the low loads at which the automobile usually operates. Because of the mass production techniques developed during the war in the aluminum industry, resulting in low cost of production, aluminum is likely to take the place of cast iron in the present-day automobile engine. The 30% saving in weight will certainly be used to the advantage of the owner of the family car.

Purdue University

On Dec. 10, the Purdue Student Branch held a meeting at which E. L. Monson, development engineer at Nash Motors Division of Nash Kelvinator Corp., was the principal speaker.

The topic of Monson's discussion was "Frameless Automobile Design," and consisted of a resumé of advantages and disadvantages and of manufacturing processes involved in the frameless or "Unitized" design of automobiles. Some of the advantages gained by this construction were enumerated as: very low noise level resulting from stiffness and absence of rattles; a slight saving in cost and weight; ease of assembly due to the utilization of major subassemblies; and ease of repair of collision damage because of the localization of damage to the impact area, and the availability of the various body stampings for replacement.

Monson stated that although the high cost of tools and the difficulty of solving many new design and production problems has heretofore detained the appearance of many frameless type automobiles in this country, there will be considerably more development of them in the near future.

Monson's talk was well received by an audience of approximately 100 students and visitors.

On Dec. 17, members of the Purdue Student Branch went on an inspection trip to the Fairfield Manufacturing Co., where they witnessed the manufacturing processes involved in making various types of industrial gears and truck and bus transmissions.

Lawrence Institute of Technology

"What is an Industrial Engineer" was the theme of a discussion at the bi-monthly SAE activity session at the Lawrence Institute of Technology. Guest speaker for the session was Mr. Lloyd Bagby, consulting engineer and professor of mathematics at the Lawrence Institute of Technology. He began briefly giving the trends in engineering specialization, their history, and their desirability. From the two early historical classifications of engineering into civil and military, the speaker found in an ever expanding industry, cause for the present extensive differentiation of technical groups. Included in the presentation was a careful analysis of the personnel qualifications for each of the specialization stages given above.

Emerging from the turmoil of industrial change and development the industrial engineer is the present day counterpart to the original general engineer. The intensity of specialization has become so pronounced that the need of liaison has become a paramount factor to modern industrial existence. Today this liaison is the realm of the industrial engineer. Many of the popular misconceptions on the part of the layman regarding the role of the industrial engineer as a heartless efficiency expert, who is constantly striving to deprive the workingman of a job, were dispelled by Bagby. The present day industrial engineer is fundamentally a production man, and not an efficiency expert. The speaker concluded by examining a number of interesting phases of problems he has recently solved for local industry.

University of Oklahoma

On Nov. 13, the SAE Branch of the University of Oklahoma held a regular meeting at which time Dr. D. R. Frey, Research Engineer for the Anderson-Prichard Oil Corp., presented an excellent paper on "Additives for Lubricating Oils." Frey traced the development of additives through the last few years, and presented data on the characteristics of heavy duty oils, and comparison between the regular, premium, and heavy duty oils.

On December 6, a group, consisting of twenty-six SAE Enrolled Students and three faculty members, went on a tour of inspection through the Continental Oil Refinery at Ponca City, Okla. That evening, this group attended the regular meeting of the Mid-Continent Section of the Society which was held in Ponca City. This was a dinner meeting at which time two papers were presented.

John B. Hiday of the Delco-Remy Co. presented a paper on "Electrical Equipment for Personal Airplanes." Hiday's paper was chiefly concerned with his company's development of a battery ignition system for light planes, similar to that used in automobiles.

The second paper was given by Herb Rawdon, assistant chief engineer for Beech Aircraft Corp. Rawdon's paper was on the development of the "Beech Bonanza," a four passenger, low-wing monoplane, having tricycle landing gear, and the unconventional V-type tail. The Bonanza, he reported, cruises at 175 mph, carries four 170 pound people, and 100 pounds of baggage. It lands at 46 mph, has a range of 750 miles at 165 mph.

French Lick Signed For Summer Meeting

DUE to the inability of the Greenbrier Hotel management to reconvert the former Army general hospital at White Sulphur Springs, W. Va., back to one of the country's most attractive summer hostelries in time for the SAE 1947 Summer Meeting June 1 to 7, this event will again be held at French Lick Springs Hotel, French Lick, Ind., according to Chairman Ralph R. Teetor of the SAE Meetings Committee.

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Despite every effort to rehabilitate the White Sulphur hotel, materials and manpower shortages caused delays which make it impossible to be ready for the Society, according to Loren R. Johnson, who is in charge of the work as special representative of the president of the Chesapeake & Ohio R.R.

Hence the tentative reservation for use of the French Lick hotel has been confirmed. (Tentative reservations have already been made for the 1948 Summer Meeting at the Greenbrier, June 6 to 11, Mr. Teetor said.)

As soon as the War Assets Administration announced the availability of the White Sulphur property as surplus, and before the railroad again obtained possession of the property, the Meetings Committee contacted Mr. Johnson and made the tentative 1947 reservation, now cancelled.

Young Named Chairman Of Spring Aero Meeting

RAYMOND W. YOUNG, vice-president in charge of engineering, Wright Aeronautical Corp., has been confirmed by Council as general chairman of the SAE 1947 Aeronautic Meeting (Spring) April 9 to 11, at the Hotel New Yorker, New York.

This national meeting will be sponsored, as heretofore, by the Air Transport, Aircraft, and Aircraft Powerplant Activities of the Society, with the cooperation of Metropolitan Section.

Meetings committees of the three activities have already met, and are completing their detailed plans for what is expected to be the most important and best attended Spring Aeronautic Meeting in the Society's history.

Council action was taken Dec. 3 at its meeting in Chicago.

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New Members Qualified

These applicants who have qualified for admission to the Society have been welcomed into membership between Dec. 10, 1946, and Jan. 10, 1947.

The various grades of membership are indicated by: (M) Member; (A) Associate Member; (J) Junior; (Aff.) Affiliate Member; (SM) Service Member; (FM) Foreign Member.

Baltimore Section: Glenn O. Biser (A), Frank Goodwin Hubbard (A), M. Gore Kemp (J).

British Columbia Group: Ralph A. Lees (A), Andrew M. Lovick (A), John Bernard Tompkins (A).

Buffalo Section: Richard Adams Batt (J).

Canadian Section: Harold J. A. Chambers (M), W. A. R. Davis (M), Hess Finestone (A), Clifford Alton Rourke (A).

Chicago Section: Don Peter (A).

Cleveland Section: Jack Beavis (M), John J. Gapstur, Jr. (A), Ralph E. Grey, Jr. (J), Robert F. Oster (J), Arthur E. Stevens (M), Earl D. Watson (A), Robert Wayne Wilson (J).

Dayton Section: Robert E. Arndt (J), Ralph R. La Motte (M), Herbert H. Ruhl (A).

Detroit Section: Merrill J. Anderson (M), Howard E. Hesselberg (J), Pierce Hollingsworth (J), Ensign William Parshall Kalb (J), Bernard Meldrum (M), Raymond C. W. Peterson (A), R. J. Wahrenbrock (M), Robert M. Worth (A), Rolla V. Wright (A).

Hawaii Section: James Allan (A), Alvin T. Hanson (A), G. Rae Meisner (A), Richard H. Miller (A), Ralph Howard Moyers (A).

Indiana Section: James P. Leamon (J), Hubert L. Suddeth (A).

Kansas City Section: Claude L. Johnson (M).

Metropolitan Section: Philip Albo (A), Robert H. Arnold (M), Bruce S. Bailey

(J), Harry L. Baker (J), Charles Luther Best (J), Anthony Owen Bird (A), Francis A. Breen (M), Richard L. Burke, Jr. (J), William Edwin Burns (M), Harrison W. Burton (J), Michael Caruba (J), William Francis Davis (J), John E. Dickson (A), Kurt Erdmann (M), Gene W. Goble (A), Walter R. F. Guyer (J), Joseph P. Hannon (A), Frank J. Hart (J), Chester W. Hoffman (M) John C. Hollis (A), Frank Maizel (J), Michael J. McKenna (A), Bernard L. Moss (J), S. Edmund Nichols (A), Carl Louis Otto (M), James J. Perkins, Jr. (A), Anthony E. Robertson (M), Thomas M. Ryan (M), Phillippe L. Schereschewsky (FM), Paul Schwartz (M), Ralph H. Shepard (M), John T. Tepley (J), Edwin A. Tervo (J), William J. H. Vossbrinck (M), John R. Walters (A).

Mid-Continent Section: Martin Edward Nash (J).

Milwaukee Section: Herbert K. Brown (J), Martin Spencer (J).

New England Section: Denham G. Jaycock (A).

Northern California Section: E. A. Dillon (A), Joseph Clark Dixon (J), W. Porter Miller (SM), Roland J. Morgan (A), Jack R. Stitt (J).

Northwest Section: Lewis Holmes Burnett (A).

Oregon Section: Alexander Rankeillor Arnot (A), John M. Barnes (J).

Philadelphia Section: Paul Robert Elder (A), George W. Pusack (J), Raymond B. Rogers (A), Raphael Teitlebaum (M).

Pittsburgh Section: Clarence Edward Cox (M), Robert P. Gilmartin (J), Elmer W. Schink (A).

St. Louis Section: Jack E. Fleischli (J).

Salt Lake Group: H. K. Pringle (A).

San Diego Section: Richard Gilman (A).

Southern California Section: Vernon W. Balzer (M), Reed M. Black (A), Edward M. Bonette (A), John Robert Boyd (J), H. Robert Chapman (J), Lyell S. Collins (J), Wilford Coultas (A), Paul H. Goodwin (A), Arthur J. Granville (A), Sidney Kenneth Harman (A), Don D. Holloway (J), William L. Kent (M), William T. Mickle (J), Fred Wm. Segerstrom (A), Loyd A. Somers (A), Paul Sundberg (A), Donald C. Webster (M), H. Dudley Wright (J).

Southern New England Section: Joseph Robert Demers (J), Louis H. Frese (M), Theodore Gurney (M), William C. Marsh (J), Robert F. Nostrant (J), Stanley Zaimor, Jr. (J).

Twin City Section: Herbert Neal Berge (A).

Virginia Group: Lucien W. Bingham, Jr. (J).

Washington Section: Howard C. Adams (M), Leo Morse Chattler (SM), Lloyd Rutherford Worden (A).

Western Michigan Section: Kenneth C. Atkin (A).

Wichita Section: Paul E. Sutoris (A).

Williamsport Group: Ralph T. McRae (J).

Outside of Section Territory: Richard Junior Alkema (J), Earl A. Bohner, Jr. (J), J. M. Johnston (A), Robert Andrew MacGregor (M), Doane Morris (A), Robert Phillip Woolery (J).

Foreign: Arthur Capella (J), England; Roland Claude Cross (FM), England; Arthur Davenport (FM), England; Jack Eliot Duckham (FM), England; Nuh Ergeneman (J), Turkey; G. P. Khandelwal (J), India; Bjorn Oscar Kjellberg (J), Sweden; A. M. Mangoury (A), Egypt; Rudolph Podsednicek (FM), Czechoslovakia; Bernard Albert Raven (FM), England; Percy Southern (A), England; John Noel Hutton Tait (FM), England; Robert Oldfield Wilson (A), England.

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Applications Received

The applications for membership received between Dec. 10, 1946, and Jan. 10, 1947, are listed below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

Baltimore Section: Ward L. Bennett, Arnett J. Franchi, John I. Yellott.

British Columbia Group: Arthur R. Brown, Robert V. Clarke, Frederick Myles Herbert, W. B. Lovis, Alan Bryanton Reid, Thomas Williams.

Canadian Section: Joseph Wilson Dyer, Stuart Grant Jones.

Chicago Section: Everett M. Churchill, Wilson Payne Green, Robert F. Nugent, Robert C. Walter, David H. Young.

Cleveland Section: George S. Case, Jr., Harold H. Christenson, Lawrence L. Gilbert, K. Theodore Korn, George F. Petsche, Jamez J. Rataiczak, Frank W. Steere, Jr., Alexander V. Toth.

Dayton Section: Paul D. McMahan, Harry Edward Rifenbark, George W. Roberts, Alfred Voedisch, Jr., Edwin M. Wright.

Detroit Section: Donald A. Arndt, A. M. Babitch, William G. Bally, W. S. Bobier, Jr., Howard L. Brown, Malcolm C. Campbell, Eldon Cox, Charles G. Dowd, Julian K. Gilbert, Robert G. Green, Dan M. Guy, John Justin House, Leroy H. Hull, John Oldham Huse, John F. Jones, Robert Roy Mandy, William B. McFerrin, Lewis F. McNitt, Ralph W. Perkins, Edward H. Potthoff, Walter J. Ruessman, L. R. Sampson, Walter H. Shealor, Austin G. Stecker, Frederick H. Stocker, John H. Stresen-Reuter, Gerald J. Theunick, Walter E. Turner, William W. Vandercook, Albert Bond Willi, Jr., Andrew R. Wylie, Edward J. Zauel.

Hawaii Section: Leonard H. Anderson, Godfrey Paul Crackel, Charles A. Devine, Jr., William A. Graham, Martin W. Hess, Frederick G. Irwin, Henry M. Souza, Sr.

Indiana Section: Roscoe L. Bell, John Leslie Gradle.

Metropolitan Section: Anibal Becher, Bernard M. Brod, Richard Garnett Burton, William Victor Caputo, William John Cesarz, Jr., George Demetrie Comnas, A. B. Culbertson, Richard R. deCampo, Gerald Doig, Leonard Epstein, Richard J. George, Donald F. Gross, Gregory M. Hebert, Frank J. Hollearn, Hugh Wallace MacDonald, Murray Waldman, Francis Logan Stansfield.

Mid-Continent Section: Dan M. Avey, Ralph W. Boyd, A. W. Chandler, Robert K. Wattson, Jr.

Milwaukee Section: Walter J. Beyer, John J. Bray, Charles W. Decker, Carl F. Zaitz, T. Russell Moyle, R. P. O'Connell, H. Russell Wilson.

Mohawk-Hudson Group: William Frost Moore.

New England Section: Walter H. Farrell, William Garber, Alfred W. Hurwitz, Roland S. Norwood, Harry Stanton, Richard Wadler, Robert M. Zimmerman.

Northern California Section: George Wayne Elliott, Arthur R. Isitt, Prof. Prentiss C. Nelson, Morris Hayden Pomeroy, Robert Urich, Marvin R. Wall.

Northwest Section: Robert A. Holmstrom.

Oregon Section: William Edward Nunnenkamp, Charles W. Simonsen.

Peoria Section: Elsworth Marvin Iverson, J. William Vollentine, Jr.

Philadelphia Section: Albert M. Best, Alfred C. Joy, Maximilian J. Palena, Marion F. Smith.

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AB-54

St. Louis Section: Benjamin Rush McConnell, Jr.

San Diego Section: Lynn Stroud.

Southern California Section: Edward I. Brown, John Tolman Burns, A. Scott Cipolla, Trevor Gardner, Don C. George, Milford D. Gibson, Leo M. Glascock, Cedric Leinbach, Mark M. Macomber, Dr. Albert J. Mueller, Pichel Wilson Pichel, Arthur Polansky.

Southern New England Section: Armand Bosco, John S. Burdick, Jr., Henry J. Dzielenski, Roy E. Elbel, Norman B. Newton, Bruno John Pawlowski, Joseph T. Rathaus.

Spokane Group: Clifton J. Nelson.

Twin City Section: G. E. Buske, Robert Raymond Johnson.

Washington Section: David K. Hart, Vernon T. Orrison, Robert E. Phelps, Gerald Reinsmith, J. Lawrence Wilkins.

Western Michigan Section: Edward G. Carlson, Robert P. Petersen.

Outside of Section Territory: Commercial Solvents Corp., Marshall H. Jones, William Warren McCutcheon, Paul M. McLaughlin, Wilfred E. Slade.

Foreign: Edward William Bennett, England; Edward Roland Dawtrey, England; Giuseppe Gabrielli, Italy; Michael Ward Kandall, England; Frank Stanner, England; Eric William Thomas Stow, England; Chen-Wen Tien, China; Bernard Eric Treganowan, England; Ngo-Ming Tau, China; Philip Edward Burdock Vaile, England.

Section News

cont. from p. 97

such data as model, serial number, weight, measurements, and so on; this fingerprints the original equipment.

2. Service record sheets, effective for six-month periods, to help in predicting service work to be done. Data are entered for predetermined mileages.

3. Truck inspection sheet outlining from service record data work to be done when the truck returns.

4. Exact working condition of the truck recorded by the truck driver on a driver's trip report which includes tire changes, comments on general performance, temperature records for refrigerator loads, and so on.

These and other records provide a complete case history valuable in checking durability of equipment and determining needed schedule changes.

Battle against smoke, Larson said, is carried on by careful calibration of fuel injectors, proper adjustment of fuel pumps, installation of automatic engine temperature control, and ample provision for air to the chambers.

Need for Synthetic Rubber Emphasized

by H. T. QUICG, Field Editor

MID-CONTINENT Section, Oct 11 – Synthetic rubber industry will act as a stabilizer on the cost of natural rubber in the future, J. A. Britton, Jr., predicted at this meeting. Speaking before a joint dinner meeting of the Mid-Continent Section and the Oklahoma University Student Chapter, Britton traced the history of the development of both natural and synthetic rubber, pointing out that chemists have been working on synthetic rubber for over 100 years. The Germans developed and used it during World War 1.

Process for making a two-component polymer, consisting of about 75% butadiene and 25% styrene, was obtained from Germany in the early '30's. This Buna S rubber represents 80% of the present Government program.

Strides made in synthetic rubber production are indicated by the jump from 2200 tons in 1942 to a predicted million-plus tons in 1946 had the war

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continued. Synthetic rubber tires were developed within a period of two years to a point where they were at least equal to prewar natural rubber tires.

Britton, who is from Stanco Distributors, Inc., announced a general feeling in this country that at least 25% to 30% of the synthetic rubber plants' capacity must be maintained in operable condition.

Buna N, he said, has a bright future because its oil resistant properties will fill a place that natural rubber never can fill. Butyl rubber is finding wide use in production of inner tubes. . . . It is approximately ten times less permeable to air than natural rubber.

Britton answered a number of questions after his paper, disclosing that

- S-3 and GRS are the same, containing less than ¼ lb. of natural rubber;
- Synthetic rubber must be vulcanized just as natural rubber is;
- Butyl tubes are not puncture proof, and
- Optimum air pressure for a Butyl tube is 28 lb.

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DOUBLE-LOCKING PALNUTS

Canadian Section Holds Annual Social Meeting

by WARREN B. HASTINGS, Field Editor

CANADIAN Section, Dec. 18 – This Section's December meeting, dedicated as always to the memory of Section Father R. H. "Bob" Combs who established this social function in the Section's early days, was highlighted by a tale of primitive travel on James Bay. Adam F. Smith, chairman of the Section's Meetings Committee and vice-president of R. C. Smith & Son, described a three-weeks' cruise in the Carwyn, a 45-foot coastal freighter with an antique 3-cyl Acadia engine. Automotive maintenance on the trip involved repairing and even manufacturing bearings, and the making and installation of a dip pan to improve bearing lubrication.

The Section's turkey raffle for the Toronto Sick Children's Hospital fund grossed over $160.

Oregon Section Flash Bulletin

HOT luncheons have replaced cold box lunches at the Oregon Section's Friday luncheon get-togethers. This is a red-letter event for Section members and their out-of-town SAE guests who have been eating their Friday lunches out of boxes since discontinuance of hot meals during the war. In lieu of attractive waitresses, Section members are doing the serving. Any SAE member in Portland on a Friday is invited to attend the luncheons, held each week at Ireland's Restaurant at Lloyd's Golf Club.

Public Asks More Of Postwar Plane

by H. T. QUIGG, Field Editor

MID-CONTINENT Section, Dec. 6 – Before the war, J. B. Hiday, of Delco-Remy Division, GMC, said, small airplanes had bare essentials for flight, but since the war the public is demanding an airplane for transportation – not just airport flying. Hiday spoke on "Electrical Equipment for Personal Planes." He believes the new plane must have the luxuries passenger car owners have come to expect – starter, radio, heater, defroster, and comfortable seats. Delco-Remy is adapting standard automotive equipment such as generators and starters for aircraft in order to keep cost down. He predicts planes will use battery ignition in the near future.

Replying to questions, he said that

carbon pile regulators are not used in small installations because of cost; that 400-cycle current in light planes would achieve some weight reduction, but would increase complication; and that cadmium batteries are not as good as lead-acid batteries.

Herb Rawdon, of Beech Aircraft Corp., traced steps in the development of the Beech "Bonanza" from the original design, through wind tunnel tests, structural tests and flight tests. It has a tricycle-type retractable landing gear, flaps with 20-deg full deflection, and an electrically controlled, continuously variable pitch propeller. It is powered by a Continental 6-cyl engine rated at 2050 rpm at sea level at 165 hp. Top speed is above 180 mph. Unconventional V tail does not improve stability or control, but saves 20 lb and $100, and increases high speed 3 mph.

Standards Asked For Car Heaters

by W. F. SHERMAN, Field Editor

DETROIT Section, Nov. 18 – An exploration of engineering requirements in the heating and air conditioning of passenger cars was offered the Detroit Section in two papers presented tonight. These complemented an earlier paper (in September) on heat and sound insulation of passenger cars. The trio of papers make a valuable contribution to the technical literature on this subject.

The two November speakers were T. C. Gleason, head of the fluid dynamic laboratory, Chrysler Corp., and V. E. Matulaitis, automotive engineer, Heater Division, Eaton Mfg. Co.

"Heat systems with effectiveness comparable to the best residential practice should be common to the automobile in the next few years . . . and active development of cooling systems may be anticipated," Gleason declared.

Meanwhile, Matulaitis disclosed that the ambiguity of ratings for automobile heaters calls for adoption of standardized methods of rating. He supported his contention with examples from current practice. The need for standards was emphasized also by Gleason, who said that it is not too early to discuss complete year-round air conditioning requirements for vehicles, and offered his paper as a preliminary survey of objectives desired.

For the most part, Gleason recommended ASH&VE standards, but with modifications and additions required by the application to automotive practice.

Both discussions mentioned the problems of warm-up, the supply of air to keep windows free of fog and moisture, the demands for de-icing of windshields, and the need for eliminating smoke and odor.

It was pointed out that air distribution affects both local temperature and velocity. Incorrect values of either are "registered by the human physiological sense as a draft." Gleason suggested that temperature differentials inside the vehicle should not exceed 3 F and velocities not exceed 50 fpm.

Only the Gleason paper dealt with summer conditions. The opinion was expressed that ASH&VE figures be the target in automotive practice. These call for 80 F inside when 95 F outside is assumed. Summer conditioning requires considerably more attention to solar radiation, Gleason declared.

Comparison of recirculating heaters and fresh air type heaters is difficult because the "rated" or "nominal" thermal capacity of a fresh air heater is very different from its "effective" thermal rating, according to Matulaitis. The thermal capacity of a recirculating heater can be more easily and accurately established, because the problem of a cold outside air supply and a continued loss of heated air is not involved. He predicted, however, that the fresh

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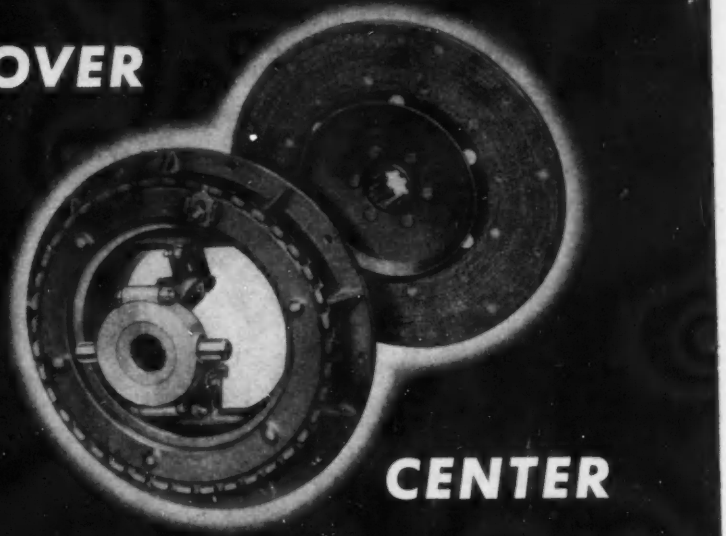

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air type heater will be generally adopted because of superior results achieved with it.

Simple System Outlined For Tire Conservation

by BERTRAM ANSELL, Field Editor

WASHINGTON Section, Dec. 10 – One-third of the vehicles on the road today have one or more punctured tires, W. J. Kirkpatrick reported at this meeting. This alarming percentage is largely a result of needless wear and destruction of tires and tubes. Kirkpatrick, who is with A. Schrader's Son, described a new and simple conservation method – the comparative air loss system, requiring seconds of time and no special equipment. It consists merely of gaging tires for pressure and, if pressure is less than that of the running mate, removing the tire and testing for leaks. Adherence to the system, he estimated, would reduce roadside flats by 90%. One large fleet owner who experienced three roadside flats per day reduced this figure to one in six months after installing the system.

Auxiliary aids to tire conservation consist in remedying faulty inflation habits:

- Tires should not be inflated hot; at least 2 hr should be allowed after driving for tires to reach atmospheric temperature.
- In order to determine whether there is air loss from the tube, the valve cap always must be in good condition and be replaced on the valve stem.
- Tires should not be inflated too frequently; about twice a week is recommended, since too frequent gaging and inflation will not allow abnormal air loss to become apparent.
- Spare should not be neglected; it should be used as a standard in determining whether or not running tires are losing air.

Back in 1897 the type of spark-ignited internal combustion engine we all take for granted today was no more than a gleam in the eye of enthusiasts. There were automobiles, of course, and tractors and portable power units of a sort, but they were clumsy and unreliable by present standards.

That was when the inventor of the first portable storage battery, Thomas Witherbee, set up shop in New York. What he made was called an "igniter" and it was, strangely enough, the lineal ancestor of today's best known *battery-less* ignition unit. In 1904 he formed the Witherbee Igniter Company and when he made a piece of equipment that developed the necessary spark *without a battery* it also was called a Witherbee Igniter. This electric igniter used an entirely different ignition method, and it could produce a strong, hot spark regardless of engine speed.

For years standard equipment on most cars and other internal combustion engines was a WICO magneto — the trade mark was taken from the initials of the original company. The business was moved to Massachusetts in 1909 and when it was reincorporated in 1920 it became the Wico Electric Company, following the trade mark.

Today WICO is the world's largest producer of magnetos exclusively, supplying many of America's largest manufacturers of farm implements, contractors' equipment, outboard motors, and large and small power units of all kinds. A well trained staff of field engineers and more than a thousand authorized service stations throughout America sell to and serve the ultimate users of these economical, reliable magnetos. Wico Electric Company, West Springfield, Massachusetts.

WICO MAGNETOS 50 YEARS OF DEPENDABLE IGNITION

Aluminum Bearings Need Special Clearances

by MURRAY FAHNESTOCK, Field Editor

PITTSBURGH Section, Nov. 26 – Aluminum bearings are doing a good job in applications where speeds are slow and oil flow copious, Edwin Crankshaw of Cleveland Graphite Bronze Co., told this meeting. Because of differences in the coefficient of expansion between steel bearing backs and aluminum, it is necessary to allow greater clearances with aluminum bearings. Suggested clearance was 0.001 to 0.0015 in. per in. of shaft diameter. Some passenger cars now use vertical clearances of less than .0005 in.

Discussion brought out that proper bearing "crush" is a function of design, and that bearing shells as received from the manufacturer provided for proper crush. Excessive crush, he said, results in deformation of the bearing caps with possibility of lubrication and bearing failure. Mechanics were warned not to file or otherwise tamper with bearing dimensions.

Dual-Fuel Engine Finds Varied Uses

by JAMES E. P. SULLIVAN, Field Editor

DAYTON Section, Dec. 3 – Complete potential uses for the dual-fuel engine have not yet been determined, H. F. Shepard told Dayton's Springfield Group tonight. However, a number of new developments which will broaden its application and increase its usefulness are now being manufactured or are on order. Shepard, who is chief research engineer of National Supply Co.'s Superior Engine Division, named

four present uses and proposals:

1. Use of utilities' natural gas at low summer rates, reverting to diesel oil in winter.

2. Use of diesel fuel for drilling in new oil fields, turning to gas as soon as available and before a market for the gas is found.

3. Use of gas from sewage disposal plants to operate plant machinery as far as available, making up the fuel deficit with diesel oil.

4. Use of diesel fuel in remote and inaccessible places, and substituting producer gas if oil deliveries fail.

Wartime Diesel Advances Call for Improved Fuels

by C. F. FOELL, Field Editor

METROPOLITAN Section, Dec. 17 – The diesel engine emerged from the war an accepted prime mover, and it possesses advantages that practically guarantee it a place in the prime-mover picture for as far into the future as it is ever safe to predict. This was the theme of an address by C. G. A. Rosen, director of research for Caterpillar Tractor Co. before the Metropolitan Section. Rosen, who recently toured Europe as a member of a Government-sponsored committee investigating Continental developments in the internal-combustion field, drew on that experience as well as on his lifetime association with this phase of American industry in assaying and projecting the impact of the diesel engine.

Curiously enough, he went on to say, the diesel has received much of its improvement as a result of war needs. Research and development by the Germans provided an engine capable of meeting the power needs of the submarines of World War I. Thereafter, refinements and major and minor improvements contributed by engineers the world over resulted in ever-lower weight-horsepower ratios, increased reliability and greater simplicity in operation and control.

Some of the most advanced steps culminated in the powerplants designed by the Germans for their World War II submarines and certain of their rockets. For submarines, the major element of the plant continued to be the diesel, but the fuel, combustion, and exhaust systems were so modified that underwater propulsion with the main powerplant was made possible and feasible. These plants were supplied with the necessary oxygen from tanks of the gas in a highly-compressed state or with oxygen released from hydrogen peroxide maintained in a highly-unstable condition.

Years ago, Rosen continued, diesel engines weighed 400 lb. per bhp and developed about 25 lb per sq in. bmep; today, the specific weight is only a small fraction of 400 lb and commercial bmeps range from around 80 to 120 lb per sq in.; in 1935, specific outputs were 0.121 hp per cu in. of displacement, today they average 0.887 hp per cu in. And, in giving these figures, he emphasized that they, too, are undoubtedly transitory . . . American builders are achieving laboratory results up to 360 lb per sq in. bmep, and when such research can be resolved into commercial engines, enormous advances will have been recorded.

At present, the gas turbine is probably the chief competitor of the diesel engine; later on, the accepted prime mover may be a combined unit, with the engine, of the free-piston type, serving as a furnace to provide hot gasses to the primary turbine that functions as the true power-producing member. At present, the diesel is actually ahead of the gas turbine.

Turbine progress awaits the development of new alloys that will permit higher temperatures, whereas standard engine materials now in use successfully withstand temperatures which are higher than the turbine expects to

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meet for some time after new metals are ready for it. Rosen stated that reciprocation can very likely be credited heavily in this respect—heat is released intermittently and portions of the working areas are exposed to it only intermittently, so that average temperatures remain moderate.

In closing, Rosen praised the oil industry for meeting the needs of internal-combustion engines. Lubricants generally continue to be quite satisfactory, but better fuels will be needed if all the possibilities of the diesel are to be realized. Fuel corrosion difficulties require solution, and the research called for indicates that both refiner and engine builder will have to cooperate closely in order to achieve worthwhile results.

Prepared discussions were given by William Holaday, director of laboratories, Socony-Vacuum Oil Co., Inc.; Albert Blackwood, Assistant Director of Research, Esso Laboratories of Standard Oil Development Co.; and William Aug, Assistant Director of Research, Mack Mfg. Co.

The meeting was arranged by Richard Creter, Met Section vice-chairman for diesel engines, who also introduced the speakers and conducted the informal part of the discussion period.

Airplane Stability Testing Described

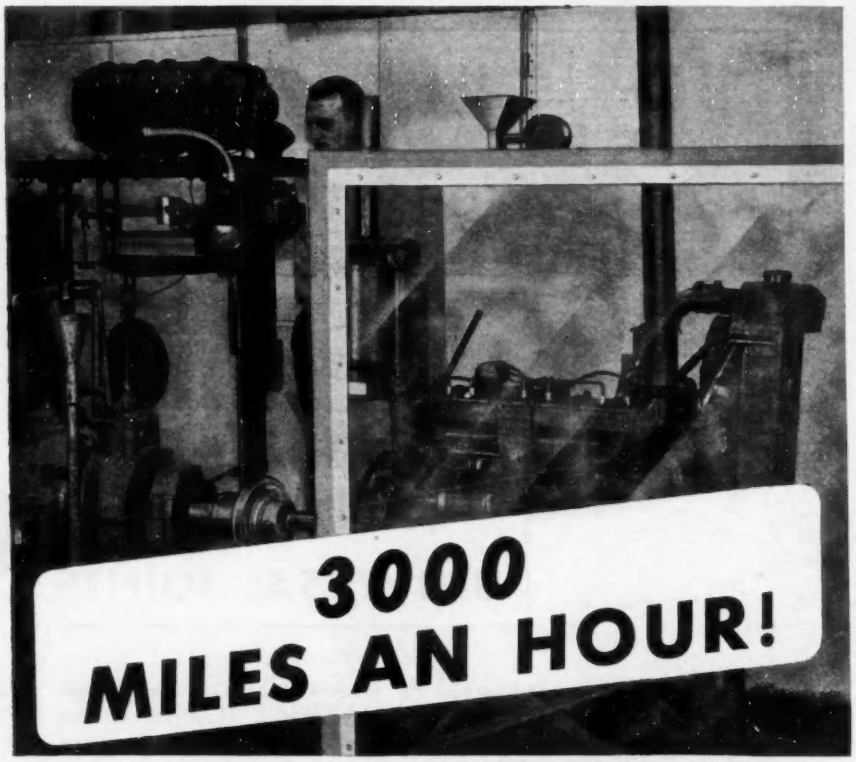
by GEORGE W. BAUGHMAN, Field Editor

WICHITA Section, Nov. 14—How to measure longitudinal stability was discussed here by C. J. Peirce, of Boeing Airplane Co., in a paper on "Airplane Stability." For power-off, he said, usual procedure is to mount a scale model of the airplane in a wind tunnel and measure the variation of lift coefficient, drag coefficient and pitching moment as the angle of attack of the model is varied. As angle of attack increases, lift increases linearly and then stalls. Drag increases slowly with lift coefficient and increases rapidly near the stall. Pitching moment coefficient is substantially a straight line until near the stall. The slope of this pitching moment coefficient curve is a measure of longitudinal stability. As this slope increases, stability increases.

For a center of gravity located at 15% of the distance from the leading edge of the mean aerodynamic chord, slope is greater and hence stability greater than for the 25% location. Stability is least for the c.g. location at 40% of the chord. For a c.g. aft of the neutral point—that is, where a vertical line is produced—the airplane is unstable. Corresponding curves for the other elevator positions are parallel; different elevator positions do not affect stability, but merely change the trim point, where the moment is zero.

Airplane designers' problem is to restrict the movement of the c.g. in a horizontal direction in order to restrict changes in the longitudinal stability of the airplane.

Application of power considerably complicates the basic problem. Only reliable test method is in a wind tunnel with powered models. Computations and analysis of data thus obtained give a series of curves called the power-on operating pitching moment curves. Slope of this operating line is a measure of power-on stability of the plane, and also of long period dynamic stability (the likelihood of slow oscillations in a vertical plane if the airplane is slowly displaced from its trim attitude while in flight). Slopes of individual power lines are a measure of maneuvering stability, indicating how stable an airplane is for a sharp displacement or a sudden change in angle of attack, such as would occur in a pull-up.



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About SAE Members

cont. from p. 90

Previously president and treasurer of the Lumalett Cooperatives Service, Bridgeport, Conn., **LOUIS M. PAWLETT** is now with Sikorsky Aircraft Division of United Aircraft Corp.

S. J. WHEELER has resigned active interest in the Synchro-tac Instrument Co., Pty., Ltd., to take full-time control of the Instrument Test House in Melbourne, Australia.

Until recently with Tidewater Associated Oil Co., **ROBERT SWAN** is now sales manager of Associated Engine Co., San Francisco.

Resigning from U. S. Aviation Underwriters, Inc., New York City, **WILL CLIFTON SIEVERT** is an air safety investigator on the staff of the CAB, Queens, L. I., N. Y.

J. R. T. BRADFORD, who served in the British Army for three and a half years, and won the coveted Order of the British Empire, is again with Shell-Mex and B. P., Ltd., London. He is aviation technical representative of the company.

Formerly with Weatherhead Co., Columbia City, Ind., **DONALD A. HENDRICKS** is now a process engineer with Parker Appliance Co., Cleveland.

Formerly an ensign, U. S. Navy, **NORTON B. JAMIESON** is employed as an experimental equipment engineer, Wright Aeronautical Corp., Wood-Ridge, N. J.

Prior to becoming plant superintendent for Eversharp, Inc., Chicago, **GORDON MURPHY** was employed by Fairbanks, Morse & Co.

ARTHUR W. LEGGETT, who was with Mershon Auto Repair, is now service manager for Bellevue Automotive, Bellevue, Wash.

FREDERICK W. TAYLOR has joined the Lee Wilson Engineering Co., Inc., Cleveland. He had been with S. K. Wellman Co. of that city.

Until recently with the Fram Corp., East Providence, R. I., **OTTO ENOCH** has joined the Automotive Research Department of Ford Motor Co., Dearborn, Mich.

Flotrol Systems, Inc., manufacturers of water separators, filters, and airport fueling equipment, has moved its offices from New York City to Tulsa, Okla., according to an announcement by **W. A. GRESH,** vice-president and general manager.

ROBERT F. YEE has been named manager of the Industrial Development Division of the Far East Development Corp., Ltd., Shanghai, China.

A graduate of the University of Wisconsin, Madison, **FREDERICK ARTHUR DOBBRATZ** is now stress analyst for North American Aviation, Los Angeles.

Honored by the British Government with an award of Officer of the Legion of Merit, **COL. J. H. SMITH** has returned to England having served the British Supply Mission from 1941 to 1945, where he had been assigned to New York and Washington as director of wheeled vehicle supply.

JOHN F. CREAMER, of Wheels, Inc., will direct the 1947 fund raising drive for the National Foundation for Infantile Paralysis in the auto parts and accessories field in the Greater New York Area.

Previously district manager, **H. LOUIS** has been promoted to chief aeronautical engineer, Canadian Pacific Air Lines, Ltd., Winnipeg, Man., Canada.

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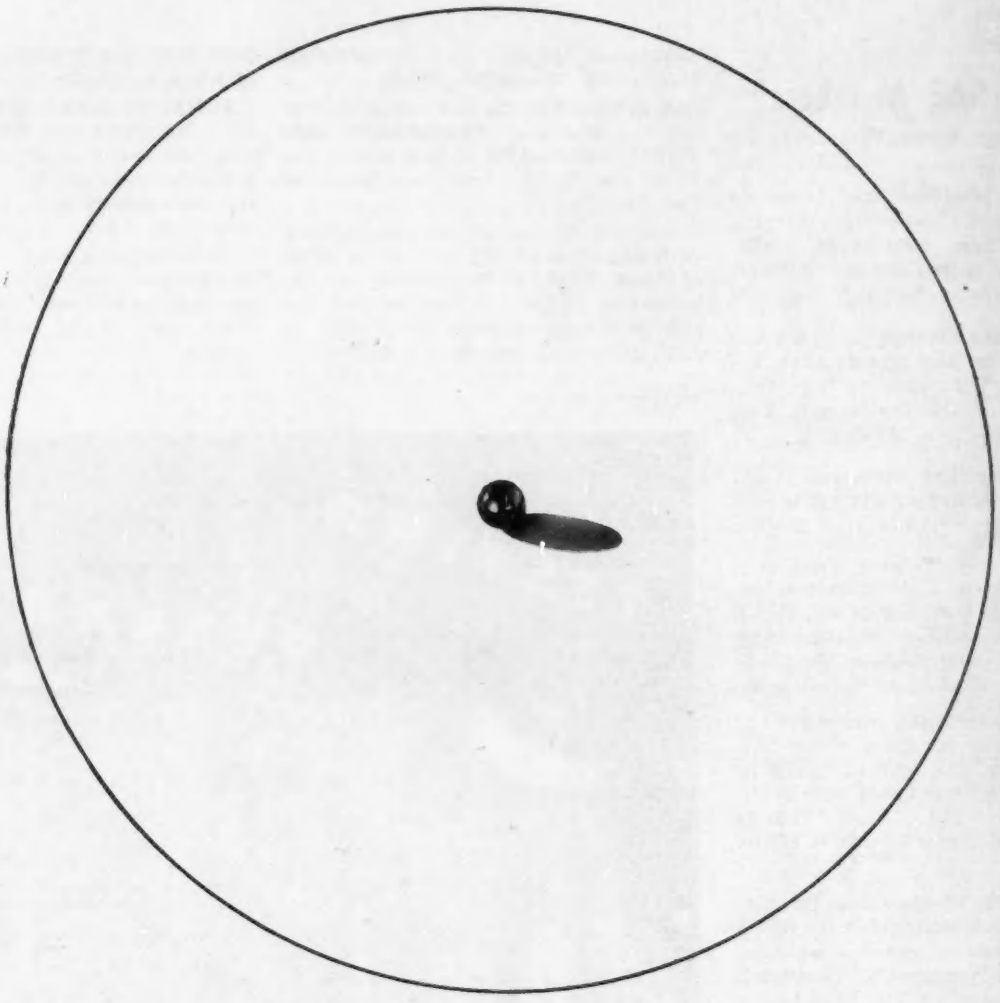

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